

Practical Guide to
Photographic &
Photo-mechanical
Printing Processes

by

W. K. Burton

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PRACTICAL GUIDE
TO
PHOTOGRAPHIC AND PHOTO-MECHANICAL
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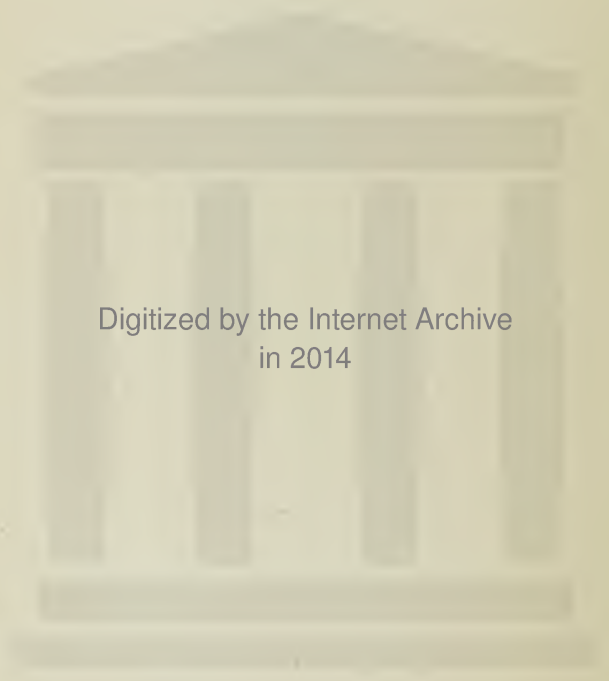
PRACTICAL GUIDE
TO
PHOTOGRAPHIC & PHOTO-MECHANICAL
PRINTING

BY
W. K. BURTON
AUTHOR OF "MODERN PHOTOGRAPHY," ETC.

SECOND EDITION—REVISED AND ENLARGED

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PREFACE TO THE SECOND EDITION

THE whole of the text has been thoroughly revised since the appearance of the First Edition, and a considerable quantity of new matter has been added. The photo-mechanical part of the work may be said to have been completely rewritten, and to have been made much more ample than it was in the First Edition.

I have to acknowledge much indebtedness to various sources. The little book, *Photo-Engraving and Photo-Lithography*, by W. T. Wilkinson, contains practical details in the working of various photo-mechanical processes that I have seen published nowhere else, and has been most useful to me. I must, on the whole, declare more indebtedness to Mr. K. Ogawa of this city than to any one else. It has been my pleasure, and has certainly been to my profit, to be associated with him in much experimental work in connection with various photographic processes,

mechanical amongst others. Mr. Ogawa has put in operation the greater number of the photo-mechanical processes described at the end of this book on more than an experimental scale, and he has made me free to publish all results whether of our joint work or of his own.

ENGINEERING COLLEGE,
IMPERIAL UNIVERSITY, TOKIO, JAPAN.

PREFACE TO THE FIRST EDITION

I HAVE to acknowledge the assistance of many who have aided me in getting the information necessary for the preparation of this book. I have freely made use of all kinds of publications on photographic matters in my efforts to acquire a practical acquaintance with processes. Wherever I can tell whence my knowledge has come I do so, but it is possible that in some cases I have not. With most of the processes described I have been familiar for some time. With others, whenever possible, I have recently made myself practically familiar. If I have sinned in not acknowledging sources of information when I should have acknowledged them, I have sinned unwittingly.

I must make special mention of one friend who has helped me more than others. The most difficult part of my task has been to get a knowledge of photo-mechanical processes. Here I have been most materially aided by T. Bolas. His lectures on the subject

before the Society of Arts I have, of course, made free use of—they constituting the standard work on photo-mechanical printing in England; but further than that, I have found Bolas ever ready personally to help me to overcome difficulties, to discover causes of defects, etc. In fact, his wide knowledge of the subject has been always at my command, requiring merely to be drawn on.

ENGINEERING COLLEGE,
IMPERIAL UNIVERSITY, TOKIO, JAPAN.

INTRODUCTION

THE term "Photographic Printing" might, with propriety, be applied to any and every process for obtaining a positive photograph from a negative,—that is to say, for obtaining a picture with the gradations of light and shade somewhat as they are seen in nature, from one in which their values are reversed, the light shades being represented as dark portions of the image, the dark as light.

It is usual, however, to confine the term to such processes as are applicable to a flexible support, generally paper, but sometimes cloth or other fabrics.

It is the writer's intention to use the term chiefly in this partially restricted sense, taking into consideration all processes which are actually practised for producing positives on paper, cloth, etc., but not leaving entirely out of consideration those for producing positives (commonly called transparencies) on glass, on china, and so forth.

The object of this work is to give practical instructions in the working of all processes which are in actual everyday use at this date, and the author's attempt will be to make such instructions of so full a nature, that they may serve as a guide to any one who may wish actually to practise the processes. To make the work as nearly complete as possible, processes which have at one time been popular, but which have been superseded by others, will

be described ; but more briefly than those which are now actually used, the interest attaching to defunct processes being really little more than historical.

In the cases of the most popular processes the chemical reactions will be briefly discussed, but the writer will avoid technical language as much as possible. He will also avoid all treatment of the purely artistic side of photographic printing, aiming to give such instructions only as may lead to that technical excellence which is *one* of the things essential to artistic work.

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CHAPTER I

HISTORICAL SKETCH OF PHOTOGRAPHIC PRINTING PROCESSES

Processes before that of Daguerre

I DO not intend to give any description of what are generally considered to be the earliest photographic processes—namely, those in which an opaque body was made to leave a record of its shadow—nor to do more than refer to the early experiments which established the fact that certain silver salts are sensitive to light. For our purpose it is sufficient to consider, briefly, the history of the art from the invention of the first process whereby a picture was got in the camera, such a picture always forming the first stage towards anything to which the term “photographic print” is applicable.

To those who wish to study the earlier processes here referred to, we commend a perusal of Mr. W. Jerome Harrison’s *History of Photography*.¹ This book, which has appeared since the first edition of my own, is a monument of patient investigation. It will probably remain for ever the source from which those interested in photography will draw their information of its early history.

¹ *A History of Photography written as a Practical Guide and Introduction to its latest Developments*, by W. Jerome Harrison, F.G.S., with an Appendix by Dr. Maddox on the Discovery of the Gelatino-Bromide Process. Bradford, J. Percy Lund and Co., The Country Press. London, Trubner and Co., Ludgate Hill. 1888.

Some may incline to ascribe to Sir Humphrey Davy the first camera photographs, he having secured images of small objects in the solar microscope, an optical arrangement somewhat analogous to the photographic camera and lens; but to Nicéphore de Niepce is due, so far as is known, the credit of producing the first photograph strictly in the sense of a camera picture. Niepce had been for several years at work experimenting with various substances, but it was not before 1827 that he produced anything which could be called at all successful. Even then it was negatives only that he produced¹—a fact greatly in favour of his process, had the thought struck him to use his results as a means to an end, but not as pictures themselves. The idea does not appear to have struck him, however, or, if it did, he was unable to work it out, for we find him, in his correspondence with his brother, describing attempts he is making to get positives directly in the camera. This was first done, or at any rate the means of doing it was first published, in 1839 by Daguerre, who took all the credit to himself of the invention of the process, known as Daguerreotype, although it is becoming more apparent, the more the subject is investigated, that the credit was really due, at any rate in great measure, to Niepce, who had entered into a partnership with Daguerre, but who died before the results of their joint investigations were published.

The Daguerreotype

The Daguerreotype was a positive process. The image produced in the camera was a positive, and, therefore, there

¹ It is only fair to say here that Niepce described a method whereby he proposed to turn the negatives got by one of his processes into positives—not to reproduce positives from them. This was by the use of fumes of iodine to darken the parts of his silver plate not covered with bitumen. I can scarcely imagine that the method was very efficient for the purpose indicated; but it seems quite possible that the use of iodine, as described by Niepce, laid the foundation of the iodide of silver process for which Daguerre commonly gets all the credit.

was no need to print from it, even had it been possible to do so.

Talbot's Process

But almost at the very same time that Daguerre published the Daguerreotype process,—one month before, in fact,—Fox Talbot in this country announced the invention of a negative process on paper. This was in 1839, and he mentions its applicability to the obtaining of positive copies from negatives. In this process chloride of silver was formed on paper, and chloride of silver on such a support forms an excellent film for positive prints, in fact, it constitutes a process for printing used even to this day, and is probably a better process than some that have almost entirely replaced it. Fox Talbot patented in 1842 a second process in which iodide of silver is used. Although it had great advantages for negative work, it was not nearly so applicable to the production of pleasing prints.

It is pretty certain that the earliest prints that are still preserved, actually produced by Fox Talbot, are on paper which had been treated with chloride of silver. Some of these still remain in a very fair state of preservation.

Toning of Prints

At a very early date in the history of silver printing it was observed that the colour of the prints, as they came from the hyposulphite bath used for fixing—that is to say, for the removal of the chloride of silver not acted on by light—varied, some being of a much more pleasing colour than others. It was found that the bath, after it had been kept for some time, gave deeper, darker coloured prints than when fresh. It was soon surmised that the darker colours with the older solution was due to the silver salts dissolved from the paper, and silver chloride or nitrate was afterwards added to the hyposulphite bath for the express purpose of giving the dark colour, of toning, in fact, this being the first toning process that we have any record of.

Gold, in the form of chloride, was subsequently used, first in an acid solution, afterwards mixed with the fixing bath, then in the *sel d'or* bath, which contained only a small quantity of hyposulphite, and was used before the fixing bath, and finally in an alkaline solution before or after fixing.

Albumen used in Printing

The introduction of albumen was brought about, at a very early date, from the desire to keep the sensitive salts of silver as much as possible on the surface of the paper. The idea of the very high gloss now common did not suggest itself. In fact, in the older prints on albumenised paper there is to be seen no gloss at all, they are only distinguishable from prints on plain paper by the somewhat finer detail that is to be seen. The gloss was a thing that came by degrees as the manufacturers improved their means of production. The gloss is considered by many, however, to be the reverse of an improvement.

I have indicated the steps whereby has arisen the printing process, which, in spite of all opposition, is the favourite process at this present day. The results obtained by its aid leave but little to be desired in the way of beauty of colour and delicacy of detail, but, alas! there is a terrible drawback to the process—the results are not permanent. It was not long after the very first prints were produced by Talbot that he observed that time had the effect of causing them to fade. Since the time mentioned much has been done to improve the permanency of prints by the favourite albumen process; and there are to be found good authorities who do not hesitate to say that, with our present knowledge, a print on albumenised paper may be as permanent as the paper itself, if due precautions be taken.

Whether this be so or not, the fact remains that since doubt was first thrown on the permanency of silver prints, experimentalists directed their attention to the working out of a process which should be undoubtedly permanent, in which the image should be formed of some substance which was known not to be subject to change.

The Carbon Process

The first process which really successfully fulfilled these conditions was the carbon process of Swan, in which the image was produced of carbon in a very fine state of division, held in suspension by gelatine. There were, however, various steps leading up to the process of Swan.

As early as 1839, Mungo Ponton published the fact that in certain conditions bichromate of potash is sensitive to light; or, to speak more correctly, may form compounds or mixtures which are sensitive to light. Thus he found that on soaking a sheet of paper with a solution of the salt, drying it in the dark, and afterwards placing it in bright light under an engraving, he got a faint yellow picture on an orange or brownish ground, which could be made finer by simply washing it in water. This discovery formed the germ of the present carbon process, which is perhaps now the best known of all processes for producing permanent prints. It was afterwards discovered that various organic substances, such as gelatine, gum, starch, etc., were rendered sensitive by bichromate of potash or any of various other chromium salts, in the sense that when treated with one of these salts in solution, dried, and afterwards exposed to light, they were rendered insoluble in water. This was a great step, for it now became evident to A. L. Poitevin, Testud de Beauregard, and others that there lay in this fact the potentiality of a practical printing process, inasmuch as, by exposing under a negative, paper treated with, for example, gelatine, to which had been applied a solution of bichromate of potash, some parts (those which had been acted on by light) would be rendered insoluble, whilst others (those protected by the high lights, or dense parts of the negative), would remain soluble, and further, inasmuch as the soluble portion of the gelatine might afterwards be washed away with hot water.

Various attempts failed, on account of the impossibility of getting "half-tone." Where the gelatine was rendered quite insoluble, as in the deepest shadows, it was all right, and the same was the case where it was left quite soluble,

as in the highest lights. But in the half-tones the film consists of a surface of insoluble gelatine, with soluble gelatine behind, the soluble protected by the insoluble from the action of the hot water, used for development, and either failing to be dissolved by the water, or if dissolved, carrying away with it the insoluble outer surface, which should have remained to form the half-tone.

J. C. Burnett, in 1858, got over the difficulty by the ingenious device of printing through the paper supporting the film of gelatine. By this arrangement all the gelatine rendered insoluble was next to the paper, whilst that left soluble was on the outer surface, and could readily be washed away.

There are, however, obvious objections to printing through the paper, one being the additional length of time involved, another being the liability that there is for any grain in the paper to show in the print. Burnett's process was therefore superseded by Swan's.

But whilst these various experimenters were working towards the process of Swan, which, to all intents and purposes, is the carbon process of the present day, a permanent process which, if restricted in its uses, was yet perfect, so far as it went, had been invented. Messrs. Garnier and Salmon, in 1858, described a process in which paper treated with citrate of iron, and exposed under a transparent positive, was brushed over with a dark powder, when a print was produced, the citrate of iron being naturally "tacky," and causing the adhesion of the powder, but being rendered hard and dry where acted upon by light, and in such parts not "taking" any powder. The process, modified to a great extent, is occasionally used at the present day under the name of the "Powder or Dusting on Process."

J. W. Swan, in 1864, brought before the public what may be looked upon as really the first carbon process of any real value for practical printing.¹ He produced what

¹ It is stated by Harrison that the principle involved in this process of Swan's—namely, the development by washing away the *back* of

he called a "carbon tissue." He somewhat modified his method within the first few months of announcing it. In its final and most practical form gelatine was dissolved in water, and in the mixture was dissolved bichromate of potash; finally, carbon in a very fine state of division was introduced so as to form a "pigment." Paper was then coated with the mixture, and was dried. It was afterwards exposed under negatives, an actinometer being used to time the exposure, as no visible image was produced. The print was now coated with a solution of rubber in benzine, and was cemented by passing it between rolls to a second rubber film which was supported on paper. Warm water was applied till the gelatine next the paper (still soluble) was softened, when the paper could be stripped away, leaving only the gelatine, soluble and insoluble, with the pigment, etc. The insoluble gelatine was then washed away by the further application of warm water, till nothing but the image or picture was left. This image was now brought into contact with the paper intended to act as a final support, albumen being used to cause it to adhere; and when the whole was dry, the application of benzine softened the rubber, and enabled the print to be stripped from the plate used for development.

The only improvement of any importance which has been made on the process of Swan arose from the discovery, by J. R. Johnson in 1869, that it is quite unnecessary to cement the undeveloped print out of the support used in development, for the reason that, if the tissue be placed in water, and be brought into contact with any waterproof support whilst the gelatine is still swelling, it (the tissue) will adhere firmly by atmospheric pressure.

It had been observed previously by Vogel that cement was not at all times necessary; but he had not noticed that the only condition necessary to secure adhesion without cement was that the support be impermeable to water. Johnson used ridged supports, such as sheets of zinc and the film, had been recognised before by Fargier and Poitevin. Be this as it may, the credit of first putting the carbon process on a working basis is due to Swan.

opal glasses, but Sawyer some time ago patented a "flexible support," consisting of paper rendered impermeable to water by treatment with varnishes.

The bichromate of potash is not always mixed with the gelatine before the paper is coated. A tissue prepared by coating paper with a mixture of gelatine, water, and colouring matter may be dried and put on one side. In this condition it will keep for a very long time, and it can be sensitised at any time by floating it on a solution of bichromate of potash in water.

Uranium Salts in Printing, Collodio-Chloride

Gehlen, in 1804, noted that uranium chloride is affected by light. But it was left for J. C. Burnett, in 1857-58, and for Niepce de St. Victor, 1858-59, to invent a practical printing process with that metal.¹

Paper was coated with a solution of uranic nitrate, and was exposed in the usual way in the printing frame. Light has the effect of changing uranic nitrate into uranous nitrate, and the latter salt has the power of reducing silver and gold salts from aqueous solutions, so that the faint image of uranous nitrate could be developed by floating the print on a solution of nitrate of silver or chloride of gold, an image in metallic silver resulting in the former case, of metallic gold in the latter. The process has now dropped entirely out of use; so far as I know, no single photographer at this date producing prints by its means.

It was known in its most popular form under the title "Wothly-type," Wothly being the name of the inventor of a particular variety of the uranium process. He deserves, so far as I am aware, the credit of being the first to use collodion on paper for positive printing. Since his time collodion, holding in suspension chloride of silver, has been used as a film for positive printing with very good results in a process invented by G. Wharton Simpson at the end of 1864.

¹ Harrison, *History of Photography*, p. 102.

The Platinotype Process

Perhaps the process which most deserves notice after the carbon process of Swan is the platinotype process of Willis, patented in 1874, and now in general use.

In this process paper is coated with a ferric salt, and also with a salt of platinum. When the paper is exposed under a negative, the ferric salt is turned into a ferrous salt wherever it is acted upon by light. Now a ferrous salt has the power when it is in solution to reduce a platinous salt to metallic platinum, and ferrous salts are soluble in oxalate of potash. It is therefore possible by floating a print of the kind described—the image in ferrous salt, on a solution of oxalate of potash—to develop an image in platinum-black,—that is to say, in metallic platinum, in a very fine state of division. The oxalate of potash dissolves the ferrous salt, which latter immediately reduces the platinous salt.

Platinotype prints are extremely delicate and beautiful in colour. They resemble in general appearance the very finest engravings, and it is claimed for them that they are absolutely permanent.

Quite recently the platinotype process has been improved by both Willis, its original inventor, and by Pizzighelli of Austria. The former has introduced a modification whereby the platinum salt is successfully introduced in the developer instead of in the paper. The latter has so modified the paper that the image comes out in the printing and development is not necessary at all.

The "Blue Process"

An application of the action of the light on ferrous salts just explained is made use of in a process much older than the platinotype. It is the well-known "blue process" used for the copying of plans, etc. It will be completely understood when I explain that ferri-cyanide of potassium takes the place of the salt of platinum in the platinotype process, and that ferri-cyanide of potassium

forms a blue compound with a ferrous salt—in fact, forms Prussian blue. The compound is, however, formed without the necessity of dissolving the ferrous salt, and therefore the blue prints can be fixed in water only.

These blue prints have for the most part been used in copying plans, the prints showing white lines on a deep blue ground ; but quite recently the process has come somewhat into fashion for printing from a certain class of landscape negatives.

Processes requiring but short Exposures, and suitable to direct Enlarging

For the production of enlargements it has always been considered advisable to have a process more rapid than any of those just described, because, unless very expensive appliances with large lenses, etc., be fixed up, the time taken to enlarge with any ordinary printing out process is enormously long. Even with the solar, enlarging arrangement just referred to, the photographer is dependent on bright sunshine. It is of course unnecessary to say anything as to the uncertainty of his having it in this country.

When more than one enlargement is required, it is common to make an enlarged negative from which large prints are taken in the ordinary way, and this process is, as a rule, gone through even when only one print is wanted in any of the printing-out processes ; but it has always been the desire of photographers, for at least some of their work, to be able to enlarge directly without the intervention of a negative.

Iodide of silver on paper (the calotype process without the oiling of the paper) was at one time much used, a comparatively brief exposure giving an image which could afterwards be developed. Afterwards “collodion transfers,” as they were called, were very popular. These were simply transparencies on wet collodion films transferred from glass to paper, and such transfers are, in fact, still used for a deal of the cheaper form of enlarging work.

Gelatino-Bromide Printing

Recently gelatino-bromide paper has been very much used for the purpose just indicated. Its use appears to have been first suggested by Peter Mawdsley in 1874. Swan, probably unaware of Mawdsley's earlier invention, patented the process in 1879. The first gelatino-bromide prints that I ever saw were in his hands, and were shown in Edinburgh a little after that date. They were small, but in all other respects would be considered very creditable productions even at this day.

It was not, however, till several years after the date just mentioned that gelatino-bromide became at all popular. Since its first commercial introduction, however, it has gained very rapidly in public estimation, and now it is used very extensively both for direct enlargement and contact printing. Its makers claim permanence for it, and there can at any rate be no doubt that prints produced on it are far more permanent than those on its rival—sensitised albumenised paper.

Gelatino-Chloride Processes

Quite recently two processes in gelatino-chloride of silver have gained great popularity. The one is a process by development, the other a process for printing out. The introduction of the former of these produced quite a sensation in the photographic world in the years 1884-85, the process being really the first in which prints having the appearance of those on albumenised paper could be produced with a short exposure to artificial light and subsequent development. I do not defend the photographic public in taking a print on albumenised paper as their standard, but such a print has undoubtedly been the standard at any rate till quite lately. Lately there has been a decided tendency towards an engraving black or deep gray as a standard.

The second of the two emulsion processes mentioned is

a gelatino-chloro-citrate emulsion,—that is to say, an emulsion containing both chloride and citrate of silver, and also generally citric acid in excess. It prints out in the same way as sensitised albumenised paper, and is toned on a bath somewhat similar to the old *sel d'or* bath already mentioned.

CHAPTER II

HISTORICAL SKETCH OF PHOTO-MECHANICAL PRINTING PROCESSES

FROM the very earliest days of camera photography, it was in the minds of photographic experimentalists that it should be possible to print by mechanical means from blocks photographically prepared. That it should be possible to print in the printing-press from blocks which were really nature-blocks untouched (in the sense of drawing, hand-cutting, etc.) by hand.

The problem has been most perseveringly attacked, with the result that many processes of greater or less degree of perfection have been worked out.

The great difficulty to be overcome was the production of "half-tone." To produce two tones merely, a white and a black, as in the copy of a pen and ink drawing, was a comparatively easy matter ; but to produce besides these all the intervening gradations, such as we see in nature or in a good photograph, was a most difficult matter.

Blocks produced by photo-mechanical processes may be divided into three groups : (1) Those in which the parts of the block intended to print black are sunk, cut, or etched under the general surface. These are known as intaglio blocks or plates. In these the ink is first applied generally to the surface, it is then rubbed off the elevation, and afterwards the remainder extracted from the depressions by the paper, thus forming an image dark in proportion to the depth of the depressions ; (2) processes in which a film is

so treated that various parts of its surface differ in their capacity for absorbing a greasy ink, or in repelling it, careful inking resulting in an image on this surface, of intensity varying with the capacity of the different portions of the surface to absorb ink. This image in ink is afterwards transferred by contact to paper; and (3) type blocks in which the elevations receive the ink which is afterwards taken up by the paper, the half-tone in such a case being produced by some sort of stipple, or lining, or grain, as in various kinds of engravings.

In the case of the first two of the three groups of processes (especially the first of all) very careful inking up is required, and the proofs can only be pulled comparatively slowly. In the case of the third process, the blocks can be printed in the ordinary way with type.

Besides the photo-mechanical processes mentioned above which reproduce half-tone, there are various processes for representing two tones only. These are most useful in reproducing plans and maps, pen and ink drawings, etc., and are, in many cases, superseding wood-engraving, as by their means the artist, drawing on white paper with black ink, may have his drawings reproduced with absolute accuracy, in place of being reproduced as the wood-engraver chooses, or is able to interpret them.

To only one photo-mechanical process that I know of can the term "half-tone" be applied with the strictest accuracy. In this one process only is there the absolute and uninterrupted gradation that we have in a silver or a carbon print. In all others the half-tone impression is produced in a manner somewhat similar to that in which it is got in a wood-engraving.

Printer's ink in reality gives only one tone, a black or at any rate a dark colour. In an engraving there is really only one tone, or two if we include the whiteness or tint of the paper as one, the appearance of half-tone being produced by dots or lines of absolute black, having between them the white of the paper. The relative depth of the various half-tones is not due to variation of the colour of the ink, but to variation of the ratio of area occupied by

black lines or dots, and of intervening white paper. Thus for a very dark shade the black lines or dots are broad or large, with but little space between them ; for a light shade the lines or dots are thin or small, and far apart.

It may, with some reason, be contended that this is not strictly true, inasmuch as no ink is absolutely opaque when in very thin layers, so that there may be said to be a certain amount of half-tone in some parts of a photo-engraving, whilst, if matters be pushed to their farthest, the pigment used in the Woodbury process to be described must resolve itself into a grain. The reader will, however, I hope, understand the distinction that is intended.

The Woodbury-type Process

This is the only photo-mechanical printing process in which it can be said that there is a true gradation in the strictest sense of the word, in which the various shades are produced by varying thickness of a coloured transparent pigment, the darker shades being represented by greater thickness than the lighter. The process is known as the Woodbury-type, after its inventor, the late Walter B. Woodbury.

Roughly, the process consists in producing an intaglio or sunk-in impression of the object to be reproduced, the deepest portions representing the darkest shadows. This mould is then filled in with transparent coloured ink, which is afterwards removed on a paper support.

The first hint of the method of producing the intaglio image that I can discover is contained in a patent granted to A. L. Poitevin in 1855.

It is not, however, necessary here to describe this or the earlier and only partially successful processes of Woodbury himself. In all these, as also in the finally successful process, an image in relief was produced by the use of a film of bichromated gelatine. This was dried, exposed under the negative and developed with hot water. The unexposed parts of the film were left soluble, whilst the other parts were rendered soluble to depths corresponding

to the intensity of the light. It will be obvious that, as in the case of carbon printing, it was necessary to expose the film from the back.

From the relief thus got it was necessary to get an intaglio or sunk impression to print from. It had been attempted to do this by electrotyping the relief whilst still wet, but there were certain mechanical difficulties in the way of getting perfect electrotypes from the gelatine relief blocks on account of their swelling in the electrotyping fluid. The discovery was, however, made by Woodbury that, if the gelatine reliefs were dried, they were so hard that they would produce an intaglio image in lead or type-metal by simple pressure, the gelatine actually sinking into the metal block. From this intaglio a casting on paper was made by pouring a warm mixture of water, gelatine, and transparent pigment into it, laying a sheet of paper on it, and bringing down a platen so as to squeeze out all the superfluous liquid. The platen was left down till the gelatine was set stiff, when it could be lifted, and the proof set on one side to dry.

The process has been simplified in various details, but in all essentials remains as it has been described, unless we consider the quite recent process entitled Stannotype, almost the last outcome of Woodbury's inventive genius to be but a modification of it. In this process an intaglio block is produced directly by exposing a film of bichromated gelatine under a *transparency*, and developing with hot water. This block, when dry, is used to print from directly, tinfoil being used as a protective film to prevent the gelatine intaglio being attacked by the water of the pigment.

Ordinary Engraving Processes

Before considering the various photographic methods of printing by photography from intaglio plates wherein a simulation of half-tone is produced by such lines, dots, stipple, or grain, it may be well to say a word or two on ordinary engraving from metal plates, lest my readers

be unacquainted with the general principles of the processes.

Copper-plate line engraving may be taken as a typical case. A polished plate of copper is used, and lines are cut into the surface in either of two ways. The graver or dry point is used, and the lines are actually cut away or impressed by hand. The results are very fine, but the work is difficult and tedious. An easier method is to cover the surface of the plate with a thin film of wax. This is scratched away in lines by needles with points more or less sharp, and the plate is afterwards treated with some etching fluid, which will eat away copper. This fluid does not act where the surface is protected by the wax, but eats away the copper where it is not. The wax is afterwards removed.

The method of printing from such an engraving is as follows:—The whole surface of the plate is covered with printer's ink by dabbing it on. Afterwards all except that which has sunk into the lines is removed by skilfully wiping the surface of the print first with a cloth, then with the hand.

The plate properly inked, paper is brought into contact with it, the paper is backed up with flannel or other somewhat elastic padding, and the whole thing—plate, paper, and backing—is subjected to great pressure by drawing it between a metal plate and a roller. The paper is thus forced into contact with the ink in the lines, and an exact copy of them is the result.

A process which is much more nearly allied to various half-tone photographic processes than line processes, is that known as “mezzotint.” It depends in principle on the fact, that if the polished surface of the copper be merely roughened it will hold the ink, and will hold it in proportion to its roughness, a stipple being produced, in which the ratio of black to white is greater, the rougher the surface is.

The first operation is to roughen the *whole* surface of the plate by means that it is not necessary here to mention. The engraver then works by *smoothing* those parts of the plate which are to represent the lights. He uses tools

called scrapers and burnishers, smoothing to just such an extent as he knows by experience is necessary to produce the tint he requires.

In aquatint a stipple is produced by covering the surface of the plate with a spirit varnish, which, in drying, cracks up into minute fragments. The plate then being bitten with acid, a half-tone, much resembling that of a crayon drawing, is produced. This is worth mentioning, as in a manner very similar to this was a stipple first produced in photo-engravings.

Very early Photo-Engraving Processes

The earliest record that I can find of any process of the nature of photo-engraving is by Poitevin, who, in 1842, attempted to turn the Daguerreotype image into an engraved plate. He gives accounts of methods of producing both engraved (intaglio) and raised blocks, but it is not clear whether he expected to get a rendering of half-tones by his processes, and it is quite evident that if he did he would be disappointed. His method was to electro-plate the exposed, developed, but unfixed Daguerreotype plate, when there was a deposit only on the lights (the parts represented by an amalgam of mercury), the unaltered iodide of the shadows refusing to take up copper from the solution. This produced an intaglio engraving. The method of producing a raised block depends on similar principles, but is somewhat complicated, and it is scarcely worth the space it would take to describe it in detail here.

In 1843 Claudet patented in this country a process for etching the Daguerreotype plate with acid. His specification is not so clear as to make it quite comprehensible how he proposed to proceed, nor does it appear that he made any special provision for obtaining half-tone.

Fox Talbot's Photo-Engraving Processes

The first engraving process of any real practical value

appears to have been that of Fox Talbot, patented in 1852. According to his patents now extant he makes use of the properties of bichromated gelatine. A steel plate is coated with a layer of this substance ; it is exposed under a transparent positive, and is then developed by washing it with water. Where the light has acted the gelatine swells, and is, according to the patent—although this is a mistake—mostly washed away, and an etching fluid can penetrate to the metal underneath. Where the light has acted the film is hardened, and is rendered impenetrable. The plate is then etched with a solution of “bichloride of platina,” which eats into the steel, and roughens it most where the gelatine has been washed away. Fox Talbot also patented at this time the first method of obtaining a grain for representing half-tone. He proposed to obtain it by impressing on the gelatine film, previous to its exposure under the negative, “the image of a piece of folded gauze or other suitable material.” In 1858 Talbot improved his process by introducing the use of powdered resin for the production of a grain. We here find Talbot recognising the desirability of that grain, now considered an essential to all photo-engraving processes. But the methods described were not of a kind likely to give a suitable grain in practice, and I believe that, as a matter of fact, Talbot did not use them, but trusted for the necessary “tooth” or grain to the slight roughening effect of the etching fluid only, and using for such fluid a solution of perchloride of iron, and acting on copper plates. We thus have a gradation quite complete from a surface not eaten into at all to one eaten away altogether, the intermediate gradations being represented by a net-like pattern. Excellent results were obtained by the process of Talbot’s just described. Indeed, I have seen some that compare quite favourably with modern photo-engravings.

The Woodbury process has been already described. It has been made subservient to the production of intaglio engravings, to be printed from in printer’s ink, as shall be described hereafter.

Modern Photo-Engraving Processes

Coming down to the consideration of modern processes, it may be at once stated that by various methods of photo-engraving results are being continually produced so perfect that it is difficult to imagine any improvement on them. At the same time, it must be admitted that full particulars of some of the processes which produce the best results have not been published, and that, moreover, there is often uncertainty as to how much hard work has been put on the engravings.¹

The Woodbury Photo-Engraving Process

In this process a Woodbury relief is prepared exactly as in the Woodbury process already described, but that the bichromated gelatine has incorporated with it powdered glass. The relief is stamped into lead or type metal, as in the case of the ordinary process, the difference, of course, being that the powdered glass produces a grain. From the lead block a copper-plate is got by double electroplating. It has been stated that the remarkably fine photo-engravings produced by Goupil et Cie. are got by a modification of this process. But the great size of them, if nothing else, would seem to argue the statement a mistaken one.

Clic's Process

This process differs but little, in principle, from the process of Talbot last described. A copper-plate is used as by Talbot, and, as with him, the etching fluid is a solution of perchloride of iron. Powdered resin or asphalt is also used to give a grain. The difference between the process patented by Talbot and that of Clic is that, whereas the

¹ To save the trouble of continual reference, I here acknowledge my indebtedness to Sir H. Trueman Wood, whose book, *Modern Methods of Illustrating Books*, I have found most useful in enabling me to give short descriptions of processes with which I am not myself familiar.

former proposed to spread the resin over the gelatine relief, the latter spreads it in the form of the finest possible powder immediately on the surface of the copper plate, using heat to make it adhere. The difference is that between a process, to say the least of it, ticklish in the working, which, so far as I know, has never been worked with success by any one but its inventor, and one which may be looked upon as the most feasible of photo-engraving processes, inasmuch as it is worked in England, on the Continent, in America, and in Japan, giving plates that need but little working up by hand.

Waterhouse's Process

In 1880 Major Waterhouse described a process, giving what he termed a "discriminating grain,"—that is to say, a grain in which the black spots or dots are of larger size (the interspaces consequently narrower) in the shadows than in the high lights. The process, I believe, was found to be somewhat defective in practice, but the principle of a "discriminating grain" is one, the importance of which cannot be exaggerated. In fact, it is only in virtue of a "discriminating grain," or something analogous to it, that any appearance of half-tone can be given by a process in which black ink is used. To make this clear, it must be borne in mind that the ink itself gives no half-tone; that every point of an engraving surface must either print quite black or quite white. Now the mere introduction of a grain throughout a whole picture, with spots and interspaces of equal size throughout, will not help in any way to render the representation of half-tone in a photograph possible. Two tones only can be produced in this way—that represented by printing the grain on to white paper, and that represented by white paper alone, untouched, that is, by printer's ink. What is required is a grain in which any proportion of area occupied by black, and area occupied by white, may be produced. The truth would appear to be that in the case of all successful processes, except that of Waterhouse just mentioned, a discriminating grain has

been produced rather by accident than by the design of the inventor.

In Waterhouse's process a Woodbury relief, or a carbon image, is developed on a copper plate. On to this is sifted fine sand, which has been waxed by placing some wax amongst a quantity of it, heating the mass, and keeping it stirred till it is quite cold. The grains of sand striking the surface of the film enter to some distance where the gelatine is soft, producing pits. They do not, of course, enter the bare parts of the copper at all, and, throughout the half-tones they enter just in proportion to the softness of the gelatine. The film is dried, the sand is removed, and an image with a "discriminating grain" remains. This is reproduced in copper by double electro-plating, being first of all black-leaded, to make it a conductor of electricity. Sawyer, of the Autotype Company, recently improved the process by introducing powdered plumbago into the gelatine, of which the film was produced, thus avoiding the necessity of black-leading it.

Obernether's Photo-Engraving Process

The only process that I know of which differs in anything but matters of detail from those already described is that of Obernether, which is both original and wonderfully ingenious. A positive is produced on a film of gelatino-bromide of silver very rich in the silver salt. The silver of the developed and fixed image is converted into chloride of silver by the action of a mixture of perchloride of iron and chromic acid. The film is then wetted and brought into contact with the surface of a copper plate, which it etches, the chlorine leaving the chloride of silver to combine with the copper-forming chloride of copper, which is soluble in water.

Photo-Lithographic Processes, etc.

The processes that next come under consideration are surface-printing processes. Before entering into details of

the action of these, it is desirable to explain very briefly the essentials of the ordinary lithographic process invented by Senefelder at about the end of last century. Put as briefly as possible, the process of lithography depends on the fact that, if the surface of slabs of certain porous stones be made greasy in parts, if the stone be then wetted and inked with a greasy ink, this ink will adhere only to the greasy parts of the stone, not to any other. It is then only necessary to produce on the stone a design in grease, or in any greasy fluid, either by drawing it directly on the stone or by transferring it from paper, when the stone may be printed from by damping it, inking it up, and bringing paper into contact with the surface.

When we come to treat of the reproduction of line subjects, it will be seen that the lithographic process, pure and simple, can be used for reproduction of a line subject through the intervention of photography. Meantime we have to consider processes similar to lithography in that they depend on the power of the surface to attract or repel a greasy ink, and applicable to the production of half-tone.

Surface-Printing Processes

The earliest record that I can find of any attempt at a photographic surface-printing process, by a greasy ink, is of 1854. In this year Guiseppe Devincenzi patented a process wherein he proposed to transfer a photographic image in a greasy ink on to a lithographic stone, and to print therefrom. As in many other cases of the earlier specifications of photographic inventions, the wording is so vague as to make it appear very doubtful whether the patentee himself understood his invention, and to make it very certain that he is incapable of making any one else understand it by a written description. Next year, however, Poitevin described the process which has since come to be known as *Lichtdruck* in Germany, "*Collotype*" in England, with such clearness that, whatever improvements and modifications have since been made in practice, to him must be given the credit of the invention.

The Lichtdruck or Collotype Process

The collotype method depends on the fact that gelatine, in its natural state, when wetted and allowed to swell up, repels a greasy ink, whilst gelatine rendered insoluble by the action of bichromate of potassium and light refuses to absorb water, but takes a greasy ink freely.

The following is, described as briefly as possible, the method of working the process. A sheet of glass or other hard substance is coated with a thin film of bichromated gelatine. This is dried very quickly, and is exposed under a negative. A faint image is seen after exposure. The plate is next washed in cold water, when those parts which have not been acted upon by light swell up. The half-tone is in the form of a fine grain, due to the "reticulation" of the gelatine.

The printing from a collotype plate is performed precisely as in the case of a lithograph. The plate is, that is to say, damped, inked up, and printed from. The inking up requires very considerable skill. The number of impressions that can be pulled direct from a collotype plate is limited. In 1861, however, Colonel Sir Henry James proposed to transfer an image from the collotype plate to stone or zinc for the purpose of enabling copies to be multiplied, to all intents and purposes, indefinitely. The purpose for which he intended this transfer process to be used was, it is true, only for the copying of maps and line subjects; but recently the process has been elaborated, and lithographic transfers of collotypes in half-tone are produced.

Type Block Processes

We now come to the last of the three methods of printing, namely, that by raised blocks. The method in ordinary printing from types and wood-engravings is, as every one will understand, of this nature. In the case of wood-engraving a flat wooden block is used, and all that is not intended to print is cut away, the portion remaining in

relief being inked and brought into contact with the paper.

In the relief process, as in the intaglio, there is no true half-tone. The half-tone must, as in the cases already described, be represented by lines, dots, grain, or stipple of some kind.

It may be remembered that Poitevin, in his very early experiments, pointed out methods of producing directly from the Daguerreotype both intaglio and relieve blocks, but there is no indication of any method of rendering the half-tones. Indeed, it is only of quite recent years that this has been accomplished with success.

When an intaglio reproduction in stipple or other half-tone from a photograph became possible, a block reproduction became possible also, inasmuch as it was possible to transfer the impression to a zinc plate, and to etch this latter in a manner fully described in the part of this book devoted to instructions in photo-mechanical processes.

The difficulty with all blocks produced in the manner indicated when the stipple or grain is very fine—as is quite necessary for surface blocks—is to get sufficient relief, without which there is a tendency for the interspaces to become filled up with printer's ink, and consequently, except in the case of the most skilful printing, the results are very poor. Even when the printing is most skilfully performed, and when, therefore, there is no tendency to smudginess, there is sometimes a tendency to flatness and a lack of range of half-tone.

The Pretch Process

As early as 1854 Pretch patented a process for making an electro-plate impression from a plate which had been coated with bichromatised gelatine, exposed under a line negative, and developed by washing the portions away, which had not been affected by light, with hot water. He subsequently made his method applicable to the production of a raised block for printing with type, by developing the exposed plate.

Meisenbach's Process

A process in which a grain or stipple was produced by the interposition of a fine netting of cross lines, at some stage of the operation, so as to break up the half-tone, was amongst several worked with greater or less success by Messrs. Bullock and Swan for some fifteen years, when it was patented by Meisenbach of Munich in 1882. The following is a description of his process:—

“A transparent plate is hatched or stippled in parallel lines. A transparent positive is made of the object (which it is desired to depict). The two plates are joined, preferably face to face. From the combined plates a definite negative is photographed in the ordinary manner. In order to cross-hatch and break the lines of the shading, the hatched or stippled plate may be shifted once or more during the production of the said definite negative. This negative is transferred in the usual manner to form a typographic block.”

The Meisenbach process is one of the most successful in practice. If one of the prints from a Meisenbach block be examined by the aid of a powerful magnifier, it will be found that the image in reality consists of equidistant dots. In the highest lights those are of course quite absent; but in all other parts they are present. In the lightest shades, however, they are represented by the minutest points, whereas in the shadows they are so large as to run into each other.

Woodbury Block Process

Of various methods of producing type blocks by the aid of a Woodbury relief, it may be said, that in them there is a very thorough provision for obtaining a discriminating grain.

Woodbury himself worked at the production of type blocks from a gelatine relief, between which and the transparency under which it was printed there was introduced a screen of gauze or network, and producing, from the resulting grained impression, a block by pressure as already

described in treating of the Woodbury process. I believe, however, that the process has never been worked on any large scale.

Ives's Process

Ives followed in the track of Woodbury, and some fifteen years ago patented a process which appears to possess all the essentials for successful working.

The principle which he introduced was the use of an impression in relief to crush down the grain of a paper with an even and marked grain. Where the relief was highest it flattened out the grain entirely, where it was lowest it did not even touch it. Between these two extremes there was a gradation of various amounts of flattening out. The relief being inked, the flattened portions of the grain only were blackened, and thus a print having half-tone represented in dots or spots of varying sizes was produced. This could either be copied in the camera, the negative being used for the preparation of a transfer, or the image could be directly transferred to a zinc block, which could then be etched.

The process has recently been greatly improved by Ives by the substitution, for the paper, of a soft rubber pad with V-shaped grooves cut in it at right angles to each other, and a plaster of Paris reproduction of the Woodbury relief for the relief itself. The rubber pad is inked, the sides of the grooves as well as the tops, and is pressed on the plaster cast. The pyramids left by the grooves do not touch the deepest depressions of the relief, but touch all the rest, being flattened out in proportion to the height of the relief, thus producing half-tone by dots of different sizes. The image thus got is copied in the camera, and there are means whereby it is easy, when once a negative is got with half-tone represented by a suitable grain, to produce a type block from it.

Zuccato's Process

A process patented some years ago by Zuccato bears a good deal of resemblance to that of Ives. Zuccato, how

ever, in place of a grained paper, uses a block of lead or type-metal, the surface of which has been prepared by planing out very narrow grooves so as to have a series of minute pyramids. The plate is inked and the Woodbury relief is brought down on it, a piece of very thin paper being between the two. The pyramids are flattened out to a greater or less degree, producing larger or smaller spots or dots, which have a very clearly defined outline.

Many other processes could be described, but they are all more or less on the lines of those already given.

The Reproduction of Line Subjects

The reproduction by the aid of photography of subjects in line I can scarcely consider ought to come under the heading of photographic printing at all. It is really simply a mechanical printing process to the aid of which photography is called. Still the various processes are much worked, and some brief description of them may not be out of place, especially as the process, which is, perhaps, more used than any other, originated with the father of photography, Nicéphore Niepce.

It is scarcely necessary to point out that any process which is capable of giving a print representing half-tone by stipple is also capable of reproducing a subject in line. Indeed the whole difficulty consists in contriving to get the representation of the half-tone, the representation of only two colours, a black and a white, being simple enough.

In 1827 Niepce submitted to the Royal Society some pictures, taken on plates of metal covered with a film of bitumen of Judæa. The action of light on these films was to render them insoluble in various oils, in which they were otherwise soluble, so that, by giving a sufficiently long exposure in the camera, and afterwards developing with these oils, a sort of image was produced.

Niepce de Saint Victor, nephew of the last-mentioned, used the process for the copying of engravings. He exposed a copper plate coated with bitumen under an engraving or transparency he wished to copy, by which means

all the bitumen, except that under the lines, was rendered insoluble. That representing the lines was then dissolved away, and the plate was etched by placing it in acid. Almost the very same process as this is that which is commonly used at the present day for the reproduction of line subjects, except that raised intaglio blocks are generally produced.

A very favourite process for the reproduction of line subjects is that in which bichromated albumen is used.

A plate of zinc is coated with albumen which has a certain amount of bichromate of potash dissolved in it. This film, when dry, is sensitive to light just as a bichromated gelatine film is, but it is far more sensitive, and requires only cold water to develop it, as albumen is, unlike gelatine, soluble in cold water. The process gives very sharp, clean lines. After the film has been exposed—just as the bitumen film is exposed, but for a mere fraction of the time—and developed, the plate is etched.

Both these methods are adapted to the finest work where great precision is required. Where a less degree of fineness and precision are required, it is usual to have recourse to the transfer method, already mentioned in connection with the production of raised blocks for type-printing. The transfer consists, as already explained, of a surface which repels greasy ink except in such parts as form the image. The image may be transferred to a lithographic stone, from which prints may be taken directly, or it may be transferred to a zinc plate, which can then be etched so as to form a relief block for printing.

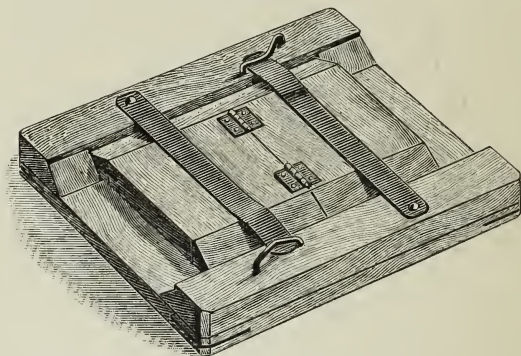
Of all the methods described, wherein a relief block is got through the intervention of a *negative* of the line subject, it need scarcely be said that, if a positive be used, an intaglio plate will result.

Many processes besides those described have been invented with the object of reproducing line subjects, but it is difficult to see any advantage that they possess over those already described, whilst they certainly appear to possess the disadvantage of being more complex in working, or more expensive.

CHAPTER III

GENERAL REMARKS ON CONTACT PRINTING

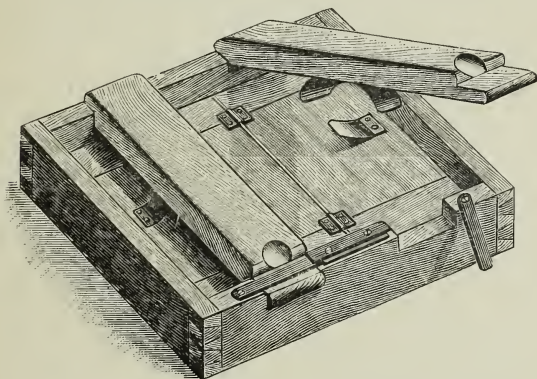
THE first and principal requisite for contact printing is a "printing-frame." Printing-frames are of various designs,



but in every case the object is the same—namely, to keep the sensitive film which is to be printed in close contact with the negative, and at the same time to provide means of examining, at any time, every part of the film, so as to see how the printing is proceeding. Provision for examination is made by arranging that one part of the film shall be kept in close contact with the negative, whilst the other is separated from it.

The simplest form of printing-frame is here illustrated. It is, in the writer's opinion, not only the simplest (and cheapest), but also the best for all small sizes, certainly up

to whole plate ($8\frac{1}{2} \times 6\frac{1}{2}$). It will be seen that it consists of a frame to hold the negative, and a back to keep the film in close contact with it. The back is made in two halves, hinged together. It is pressed by two springs against the film; but either of these springs can be released, allowing one-half of the frame to be hinged back, so that the corresponding half of the print may be examined as it progresses. In the frame just described there is nothing in front of the negative to protect it from being damaged by the strain of the springs; nor is anything necessary for small sizes. For large sizes it is, however, advisable to use the frame



illustrated here, in which there is a plate-glass front, against which the negative lies.

The back is somewhat different in form from that of the cheaper frames; but the object to be effected is the same in both cases.

It will readily be understood that, with a plate-glass frame, it is possible to print a negative of any size—from the largest that the frame will hold to one very considerably smaller. This is, of course, a convenience in many cases.

With a frame having the back in two divisions only, there is a narrow portion of the print, opposite to the hinge, which can be seen only imperfectly, or not at all. This is an inconvenience in some cases, when the very part

of the picture that we want to print for, and which is the most important of the whole, comes in the centre. The difficulty is overcome by having the back in three pieces, hinged in two places, and with three springs. It is then possible to open any two of the three parts of the back at the same time.

The backs of the frames are always covered with cloth of some kind. This is sufficient to secure contact in the case of very small sizes, say up to half-plate ($6\frac{1}{2} \times 4\frac{3}{4}$), but for plates above this size pads of some sort are necessary. Pads are made specially for the purpose out of thick felt; but the writer has found a thick pad made up of a number of sheets of blotting-paper to be quite as efficacious, although certainly not quite so convenient.

Further requisites for almost every kind of printing are: flat dishes of the size of the largest pieces of paper to be manipulated. These are generally made of very common white earthenware, covered with a surface glaze, and dignified with the name of porcelain—which they certainly in no way resemble. The glaze very soon cracks, and the earthenware absorbs a quantity of water quite incredible, and also, of course, any salts which may be dissolved in the water. I can state, as a fact verified by my own observation, that when the glaze of an earthenware dish becomes thoroughly cracked and absorbs as much of a saturated solution of a soluble salt as it can, it will keep giving up this salt again to clean water for weeks even if the water be changed every day or two.

A consideration of the facts just mentioned will make clear the advisability, if earthenware dishes be used, of confining one dish to one particular purpose, and to one only. I am glad to know, however, that recently there have been introduced dishes of real vitrified stoneware (granitine). These are non-absorbent, and if carefully washed after they are used for one purpose may afterwards be used for another.

For most kinds of printing some arrangement for thoroughly washing the prints is needed. This is specially the case with prints in silver on albumenised

paper. With these the washing must be very thorough, and many special appliances have been designed. Sundry of these will be illustrated when I come to treat in detail of the process commonly known as silver printing.

With the appliances mentioned, the photographer will be in a position to begin the practice of silver printing, and most other departments of contact printing ; but as he goes on various other appliances (all of a simple nature) will be required. For other processes further appliances will be needed. These will be described as the necessity for treating on the use of them arises.

CHAPTER IV

SILVER PRINTING

Printing with Ready Sensitised Paper—Trimming the Prints

THE article commonly entitled “ready sensitised” or “preserved” paper is now a regular institution in photographic printing. It consists of paper albumenised and sensitised before it is sold. It has the advantage that it enables the printer to begin operations without first going through the processes of albumenising and sensitising—either or both. It is very largely used by amateur, and even by professional photographers, and, whether the beginner intends eventually to sensitise his own paper or not (he is not likely in any case to albumenise it), it is certainly advisable that he begin work with ready sensitised paper.

The paper is commonly sold in sheets measuring about 17×22 inches. Twenty-four of these make a quire. The paper is sent out wrapped up so that light cannot reach it. It may, however, be freely manipulated in gas or lamp light, or in dull daylight, such as there commonly is in the parts of an ordinary room remote from a window.

The paper is cut roughly to the sizes required—that is to say, leaving a little margin—before it can be put into the frame. It is a common custom to send out sensitised paper ready cut to certain standard sizes—carte and cabinet—and the convenience of this is certainly great. It is, however, of course impossible, if the paper be cut, before printing, to the exact size, to do any trimming after printing; and it often happens, unless the greatest care be

taken in adjusting the paper in the frame, that the picture will be a shade too much to one side or the other, or too high or too low ; but in the matter of whether the printer purchases his paper ready cut or not, he must use his own judgment.

A piece of paper is placed in contact with the negative in the printing-frame, and the frame is placed in the light.

A word must be said as to the light that it is best to print in. It may probably be said that, for the great majority of negatives, the brightest light short of direct sunlight is the best. Such a light as there is in shade during the brightest summer weather is excellent. It is sometimes difficult to get the use of a place where the direct rays of the sun do not reach at some time of the day. In this case the difficulty may be got over by stretching tissue paper (white, of course) over the printing-frames. It is very convenient to have a number of light wooden frames the size of the printing-frames with tissue paper stretched over them. They can be placed over the printing-frames at a moment's notice. Some prefer for silver printing the effect of sunshine filtered through tissue paper to shadow light.

During the months of November, December, and January the brightest direct sunshine that there is in England is none too bright for ordinary printing, and indeed in London there are only about six or seven months when it is ever too bright, and even during these months the light is never too intense for more than a few hours of the day. It may be said that if, during printing in the sun, a negative gets perceptibly hot to the hand, it is probably printing too quickly. The converse, however, that if it is not perceptibly heated, it is not printing too quickly, will scarcely hold, as the sun's heat rays are sometimes stopped in passing through the atmosphere in a much greater proportion than the chemical rays.

If the negative be one with very bold contrasts, showing shadows too deep where the lights are printed out, or showing chalkiness in the lights where the shadows are

already printed out—one, in fact, giving a hard print—it may be printed in the most brilliant sunlight available. This will produce a print somewhat less harsh than could be got in a less brilliant light. On the other hand, if the negative be slightly on the soft side, giving a print lacking in brilliancy, it is advisable to print it in a light considerably duller than the brightest light short of sunshine. In fact, it should be placed in so dull a light—either by altering its position, or by placing several sheets of tissue paper over it—that it will take about an hour to print.

It requires considerable judgment to be able to tell just how far the printing process should be allowed to proceed before the proof is taken from the frame. The print loses considerably during the various processes that it has to pass through after printing, and allowance must be made for this, the printing being carried so far that the proof, as it comes from the frame, appears considerably too dark. It is difficult to give more than a hint here of the allowance that must be made for alteration of the print during toning and fixing; but I may say roughly that the printing should be allowed to go on for nearly twice as long as is required to produce a pleasing result in the frame. If the negative has been a good one—or it were better, perhaps, to say one suited to silver printing—the appearance of the print as it comes from the frame will be as follows: Looked at as a whole the impression will appear considerably too dark, the brightest lights will be slightly coloured, but only slightly so, and the shadows will appear somewhat “clogged up” on account of the fact that all the deeper shadows have gone to the darkest colour that it is possible to get with the paper by any length of printing. If the shadows be not as deep as the paper will print there is little or no chance that the finished picture will be vigorous or pleasing in colour.

The prints, as they come from the frames, may be placed in any light-tight drawer or box, to remain till there is a sufficient number ready for toning.

I strongly advise that the prints be trimmed before they are toned. A considerable saving of gold is so effected

not to mention the value of the clippings themselves ; but, besides this, there is very much less chance that the prints will be torn in going through the various baths if they be trimmed than if they be left with rough edges.

In trimming certain small sizes, especially the standard ones for portraits, there is but little latitude as regards length and breadth, such prints being mounted with but a very narrow margin.

In trimming such prints it is customary to use a "cutting shape," which is simply a piece of thick plate-glass cut and accurately ground to the size of the finished print. The print is held against the under side of this. The fact that the glass is transparent permits of the adjustment of the print to its proper position. When it has been correctly adjusted, the projecting edges of paper are trimmed away by the aid of a pair of scissors, which should have very long blades. Some prefer to use a knife, laying the shape on the top of the print on a board, or, what is much better, on the top of a revolving table, which permits each edge consecutively to be brought into the most convenient position for trimming.

I have said that in the case of some portraits the photographer is pretty well tied down as to size and shape ; but it is not so in the case of landscapes, which are mounted with a wide margin, or with large portraits, which are commonly mounted in the same way. In these cases the exact size does not matter, nor does the precise relation of length to breadth. It is, therefore, possible, if it appear desirable, to trim a little off one end or edge of the picture, or off the top or the bottom, and there are remarkably few prints that are not improved by a more or less liberal use of the shears, cutting away, perhaps, an inch of foreground or half an inch at one side, and so forth. The majority of photographers, specially amateurs, appear to be afraid to use the scissors boldly, as if they grudged to reduce the size of their prints ; but in this matter they make a great mistake. I say emphatically do not hesitate to cut down the size of your print if an improved, though smaller, picture result from so doing.

The best way in which to trim prints, when the precise size does not matter, is to mark them out on the face with a pencil, using a T-square and a drawing-board, and afterwards to cut them with either a pair of scissors or a knife and rule.

It is necessary to say a few words as to certain matters to be observed in the case of trimming. It has been observed by Norman Macbeth, a distinguished painter, that the best ratio of length to breadth in a picture is as the diagonal to the side of a square. Probably the truth of this matter is, that somewhere about two to three represents the most pleasing relation of length to breadth in a picture. Certainly anything more nearly square than that indicated is but seldom pleasing to the eye.

There are some cases in which it is quite necessary to have the sides, or the top and bottom of a print, parallel to some line in the picture. Thus, if there be a scene with the sea as the horizon line, the top and bottom of the print must be parallel with this line. Again, if any vertical buildings, or vertical objects of any kind, be introduced, it is necessary that the edges of the print be parallel with the vertical lines of the sides of the building.

It sometimes happens that it has not been possible to keep the back of the camera quite vertical during the exposure of a plate on a very high building, and that there is a convergence of the vertical lines towards the top of the print. If this convergence be but slight, it does not, I think, seriously affect the value of the picture; but care must be taken, when it exists, not to have one side of the building parallel with one side of the print, and the other edge of the building far from parallel with either side of the print. The difference must be split, and the edges of the prints must be made parallel with a vertical line, real or imaginary, down the middle of the picture.

No horizontal line, excepting the sea horizon, should ever be taken as a guiding light in trimming prints.

CHAPTER V

SILVER PRINTING—*continued*

Toning Ready Sensitised Paper

VARIOUS processes of toning of earlier date than the alkaline method of gold toning have been mentioned in the first chapter of this book ; but as they have all by this time completely given way to alkaline gold toning, they do not require further mention just now.

Toning is certainly one of the most important operations in connection with silver printing, if it is not the most important. On the manner in which it is performed depends not only the beauty of the finished print, but also, in great measure at least, its permanence.

There are many toning formulæ differing more or less from each other, and in another chapter I give a number of them with a few remarks on each ; but here I propose to confine myself to the action of one only, describing carefully the various manipulations connected with its use. The bath I select is that known as “the borax bath.” My reason for selecting it is that it is very convenient, and especially for amateurs, or all who tone only at long or irregular intervals, because it may be made up for use at once, whereas many other baths require to be kept for some time before they will work at their best.

Whatever toning formula is used the basis of it is chloride of gold.¹

¹ A platinum salt is sometimes, but very rarely, used. The writer has used “platinum chloride,” sold by a dealer for the purpose of

So-called chloride of gold is sold in small quantities in sealed tubes, each containing 15 grains. I say "so-called" because, so far as I know, the article contained in the tubes is never the pure chloride, or terchloride of gold (AuCl_3), but is a double salt of gold and potassium, or, probably in some cases, some other salt, with one or more equivalents of water of crystallisation. These salts have the advantage, which the actual chloride or, to be quite accurate, the terchloride of gold has not, of being readily obtainable in a neutral condition and of not being deliquescent. But, on the other hand, a result is that the label, "15 grains of chloride of gold," gives no guarantee of any absolute quantity of the metal, which, of course, is the active agent in the toning process. Some makers, however, guarantee in each tube a minimum of metallic gold—generally 7 grains—and it is well to purchase only such tubes as bear this guarantee. It will be understood that, hereafter, when "chloride of gold" is mentioned, the double salt just described, guaranteed to contain 7 grains of pure gold in 15 grains of the salt, is intended.

The gold having been purchased, it is advisable to make it up into a stock solution at once, so that when a certain quantity of chloride is required, it is only necessary to measure off some of the liquid. The strength of solution commonly made up is 1 grain of chloride to 1 dram of water. A tube is placed in a 2-ounce bottle, when it is broken by the aid of a glass rod, and then 15 drams of water are poured over it. A dram of this solution will then contain almost precisely 1 grain of chloride of gold.

The toning solution, with borax, is as follows:—

Chloride of gold	.	.	.	1 grain
Borax	.	.	.	60 grains
Water	.	.	.	10 ounces

About 1 grain of gold chloride will be required to toning, working with the acetate bath given hereafter, merely substituting the platinum salt for the gold. He got excellent black tones, and believes that the platinum salt might be substituted for the gold in any toning formula.

tone the prints from a sheet of paper of the usual size (17×22 inches). Indeed, if the gold chloride be up to standard, a little less would probably do, but it is better to waste a little gold at the end of the operation than to have to add gold as the toning proceeds—although it is by no means impossible to make the addition if due care be taken to prevent the local action on the prints of the added gold.

We take then for each sheet of paper to be toned 1 dram of the chloride of gold solution. This is made up to about an ounce with water. A pinch of powdered chalk is put into the liquid and is shaken up with it. The object of the chalk is to neutralise any free acid which may be left with the gold chloride, and which might be hurtful during toning. After shaking or stirring up the chalk is allowed to settle down. Meantime, 60 grains of borax are dissolved in 6 or 7 ounces of hot water. When this latter solution has cooled down, the neutralised solution of gold chloride is added to it, and the quantity is made up to 10 ounces,¹ when the mixture is ready for use.

The prints trimmed as described in the last chapter, and ready for toning, have to be washed in clean water, to get rid of the whole, or the greater portion, of the soluble salts still adhering to them.

This washing may be performed in any vessel wherein it is convenient to manipulate the prints. I think the most convenient vessel of all is a deep sink of white glazed ware sold as "Butlers's pantry sink" by various manufacturers of sanitary appliances. The sink has a plug at the bottom, and also an overflow pipe, so that the water may either be changed as often as is considered desirable, or may be allowed to flow into the sink and overflow by the overflow pipe, whilst the prints are turned over by hand.

It is, however, not every printer—in fact of amateurs probably only a few—who are able and willing to fit up a special sink for printing purposes, and I must warn all

¹ This quantity is by no means an absolute one, as will be pointed out hereafter.

from attempting to use a sink which is at other times used for negative work. In fact, the further all the operations of "silver printing" of any kind are done from the place where negative work goes on the better.

Failing a special sink an ordinary wooden tub does excellently where a supply of water from a water-tap can be got. Galvanised iron tubs may be used if they are carefully coated inside with black varnish (bitumen in benzine), or some other protective film; but there is always a little risk of spotting the prints, unless the varnishing be carefully performed; for if those ever come into actual contact with the zinc, or the iron which the varnish is supposed to cover, they will probably be acted upon.

When it is necessary to tone and fix in a room where there is no supply from a tap, and where, consequently, the water must be brought in in a can or jug and be carried away in a pail, it is, of course, advisable to economise water as much as possible, and in this case there is probably no more efficient way of washing than the lifting of prints from one flat dish to another. The method of proceeding is as follows:—Two dishes are used. Both are filled half or two-thirds with water. The prints are immersed one by one in the first face downwards, the water is then poured off, fresh is poured into the dish, and the prints are lifted one by one into dish No. 2. The water is now poured from both dishes, and fresh is poured in when the prints are transferred one by one, this time from dish No. 2 to dish No. 1. And so on the process goes till it is considered that the prints are sufficiently washed.

So much for the method of washing. The *extent* of it and various other items come next for consideration.

In giving instructions for manipulating ready sensitised paper, the difficulty presents itself that we have no absolute knowledge of how the paper is prepared. It is, in fact, prepared in many different ways, and probably to get the best possible results it would be necessary to treat each brand in a special manner. We may assume, however, that most of the different brands are preserved by the aid

of an organic acid of some kind. At any rate there can be no harm in taking such precautions as will result in the elimination of this acid if it exist, as it might be harmful did it get the length of the toning bath.

One way of eliminating the acid is prolonged washing, the other is neutralisation by the use of an alkali, for example, carbonate of soda.

I consider it best that the printer should be regulated in the matter of which method he uses by the colour he wishes eventually to have. Every one who has ever looked at silver prints must have noticed that there is a wide range of colour. A range from a light brown, through a darker brown towards a purple, into a black—and if the process be carried to the extreme, into a dull slaty-gray colour.

It is unfortunately the case that with many brands of ready sensitised papers it is not possible to push the toning to any colour much deeper than the brown without a general degradation of the print. With the best brands of paper, however, it is possible to get a good purple colour. In the case of almost all brands it is possible to get a very fine rich, warm, brown colour, which is, to the writer's mind, a very beautiful one. He has already entitled it "Payn Jennings" brown, because it has been seen in great perfection in many pictures exhibited by that eminent artist. "Ready sensitised" paper really affords this brown better than most brands of paper sensitised at home.

I shall take first the two extreme cases: one where a very warm brown (almost a red) is required, the other where a purple is wished.

It will be noticed that whenever the prints are placed in water, the water turns somewhat milky on account of the precipitation from it of salts by the nitrate of silver washed from the paper. After two or three washings the milkiness should be but slight. If it be still very considerable one or two more washings may be given. At the end of this time the prints are laid in a bath containing about half an ounce of common salt to a pint of water, where they lie for five minutes. They are then washed

in a few more changes of water, when they are ready for toning.

I have mentioned that albumenised sensitised paper may be manipulated at all stages in either dull white light, or bright gas or lamp light. Dull white light is usually preferred for toning, at any rate to the brown colour, because it is more easy to judge of colour in such a light than in the yellow light of gas.

If the weather is very cold the temperature of the toning bath may be raised a little, but it should never be made more than barely tepid—never should rise above 70° F.

The prints being ready for toning, and the toning solution being in a flat dish, a print is placed in it. The print is turned over once or twice so as to ensure thorough saturation with the toning solution, and eventually is left face downwards in the bath. Another print is similarly treated, and so on till there are several in the solution. As regards the number that may be placed in the toning bath at one time, the operator must be entirely guided by his skill. A beginner should never have more than three or four prints in the solution at once, a thoroughly skilled toner may have as many dozen. In any case the prints must be kept in constant motion by lifting the one that is at the bottom of the dish from under the others, laying it face upwards for a moment on the top of the mass of prints, when it is examined to see if the colour has changed, and is then turned face downwards.

It will have been observed that the prints assumed a very red colour in the salt and water, the red probably approaching very closely what is commonly called "brick-red." In the toning bath they will gradually change from a red to a rich brown colour. When the desired tint has been reached they are removed to a dish of clean water.

If the purple tone be desired, the prints are washed just as described for the brown tone, but carbonate of soda (washing soda) is substituted for the common salt.

The toning also is performed in just the same way. It proceeds a good deal more rapidly; but to get the purple

has, of course, to be carried to a far greater extent. If, with the treatment just described, it be found impossible to get a purple tone, the prints, in place of becoming purple, pass to a colour quite indescribable, but certainly far from agreeable; it may be concluded that the particular brand of paper used is not suitable for toning other than to a brown.

If, however, the colour goes on deepening in a satisfactory manner, the only difficulty is to stop it at the right stage. This is best done, the writer thinks, by examining the colour by artificial transmitted light, by looking through the print at a gas or lamp light behind it. The reason for this is that a little of the colour, as seen by reflected light, is generally lost during the processes which have to be gone through after toning. It is the custom of the writer, when he is toning for a purple colour, to tone till all red or brown, by transmitted light, is gone, except in the very deepest shadow of the print.

If a darker brown than the very light, warm, bright brown that I have described be desired, the prints may simply be washed for a considerable length of time before toning, till all trace, or all but the faintest trace, of milkiness has vanished, and may then be passed at once into the toning solution.

CHAPTER VI

SILVER PRINTING—*continued*

Fixing and Washing Prints on Albumenised Paper

THE prints, as they come from the toning bath, are placed at once in clean water, are washed in several further changes of water, when they are ready for fixing. The fixing agent is hyposulphite of soda, or hypo, as it is commonly called by photographers. Whilst writing of this chemical, it is well to mention that it is necessary to be most careful that no trace of it comes into contact with the print before the time of fixing, otherwise the total destruction of the latter is likely to ensue.

Various strengths of hypo bath are advised for fixing. I am of opinion that the strong baths often recommended (4 or 5 ounces to the pint) are liable to cause deterioration of the colour of the prints, especially in the lighter tints. A very good authority on silver printing, Mr. W. Ayres, recommends a bath as weak as 1 ounce to the pint. His own silver prints certainly do not indicate the fault of lack of permanence, but still I should hesitate to advise the use of a bath so very dilute as 5 per cent. As a mean between the very strong and the very weak baths mentioned, I advise one made by dissolving 2 or $2\frac{1}{2}$ ounces of hypo in each pint of water. Hypo is very cheap, and there can be no excuse for sparing it. It is, moreover, distinctly of advantage to use a large quantity of fixing bath. I recommend that not less than half a pint for every sheet of paper to be toned be made up.

It is of the utmost consequence that the fixing bath be not acid, and as many commercial samples of hypo have a slightly acid reaction, it is necessary to neutralise the bath, or still better, to make it slightly alkaline. Ammonia is, in the writer's opinion, the best alkali to use for the purpose of neutralising the bath, because, whenever it is in excess, the fact is known by its imparting its very characteristic smell to the solution. Ammonia may be poured drop by drop into the fixing bath till it (the fixing solution) smells faintly of the alkali.

The fixing bath should not be very cold (say never below 50° F.), and as hypo in dissolving renders much heat latent, cooling the solution greatly, it is often advisable slightly to warm the fixing bath before it is used. On the other hand, its temperature should not exceed 70° F.

The prints are placed in the bath one by one face downwards, care being taken to press each one well below the face of the solution before another is placed above it. When they are all in the bath the lower print is pulled from underneath the others and is laid face upwards on the top. This operation is gone through till all the prints have been pulled from the bottom of the pile to the top, and the whole thing is gone through again at the end of every five minutes till it has been done three or four times, when fixing may be considered to be complete.

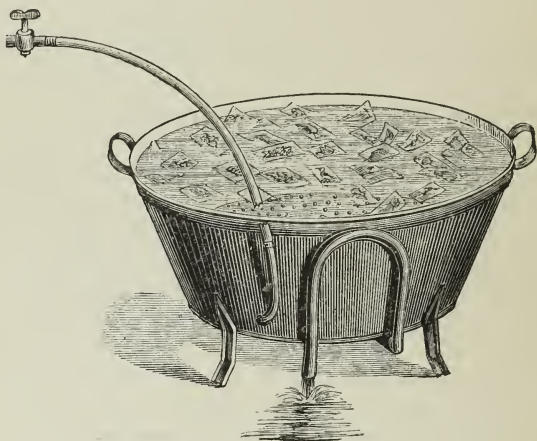
If there are a great number of prints, it is better to lift them from one dish to another, both filled with the fixing solution, than to manipulate them entirely in one dish.

The writer is of opinion that the chance of permanency of silver prints would be greatly enhanced if, after the usual time of fixing, they had ten minutes in a perfectly fresh fixing bath.

It is to be distinctly understood that the same fixing bath must never be used twice for prints. If a number of prints have been fixed, the bath is worth saving for the silver it contains. Probably from half an ounce to an ounce of metallic silver may be recovered from each quire

of paper fixed—the latter quantity, however, very rarely, if ever, in the case of ready sensitised paper.

The prints once fixed have to be washed so as to eliminate every trace of hypo. The smallest quantity of the salt left in the paper may undoubtedly cause fading of the image. But the writer here wishes to emphasise the fact that there are other causes of fading besides want of washing, and that it is not right, if prints show signs of fading in a few years, to jump at the conclusion that insufficient washing is the cause. Insufficient fixing or

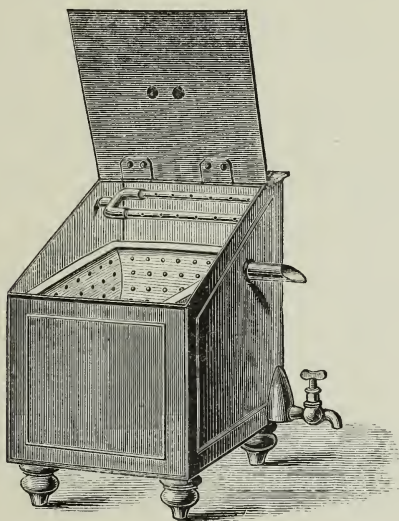


acidity of the fixing bath are much more frequent causes.¹ I believe that the second fixing bath recommended above—rendered slightly alkaline—would do more for the permanency of silver prints than all the washing machines in the world.

Still a thorough washing is at least *one* of the conditions of permanence in silver prints, and some means should be taken to secure it. The essential for a thorough washing is, that the washing water should get thoroughly at the prints; should, that is to say, act in quantities on both

¹ Andrew Pringle, *British Journal of Photography*, September 24, 1886.

sides of each print. To secure this the prints must by some means or another, be kept moving in frequently changed water, or the water in changing must be caused to move between all the prints. One or other of these two objects is attained in most of the machines manufactured for the special purpose of washing prints, the water, in entering the washing vessel, either causing the prints to keep in constant motion, or moving in rapid



currents between the prints which do not move. I here illustrate two washing machines.

The old-fashioned method of leaving the whole of a batch of prints in a tub or other large vessel, whilst water flowed constantly in from a tap and out over the edge, is probably about the least efficient of any, unless the prints be frequently turned over by hand one at a time. If they be not so turned over, they form into a mass at the bottom of the vessel, and there lie, the hypo, which is heavy, having scarcely any tendency at all to leave them. By, however, turning over the prints at frequent intervals (say

once in half an hour), having just previously completely emptied the vessel, and allowed it to fill up again, a very efficient washing is obtained in five or six hours.

Perhaps the best way in which to secure the elimination of all the hypo from prints, if a washing machine be not used, is to wash as described above for three or four hours, then to take each print separately, to lay it on a sheet of clean glass, first face downwards, then face upwards, for a few minutes, whilst a stream of water plays on it. This method will be particularly efficient if the water used for the prints when washed separately is warm.

The method described for washing prints before toning is efficient for washing them after fixing, if the photographer has the patience to carry it on for an hour or two, or can employ any trustworthy person to do so. In this case the last few waters should be warm.

The prints, once washed, may be mounted at once—wet, that is to say—although there are some objections to so doing (see Chapter XXXII.) on mounting prints. If, however, it be wished to dry them without mounting them, it is almost necessary to take some special means to prevent them from cockling up in a manner which makes them very difficult to handle afterwards.

The best way of treating prints, so that they may lie flat, is to roll them in a rolling press, but many do not possess such an article, and for this reason I shall describe a way in which they may be made to lie flat without the use of such an expensive machine.

The first thing is in any case to get them very nearly dry. A common way of doing this is by the use of drying boards. These are simply sheets of very thick blotting-paper chemically pure. Prints taken from the washing water and allowed to drain are blotted between two of these boards, and are then placed between others, a pile being made of alternate drying boards and prints. If the drying boards be not kept in a very dry place, they should be each dried by warming it before the fire just before use.

On the top of the pile of drying boards and prints is placed a weight, and the whole is left for half an hour or longer, when it will be found that the prints are practically dry. They may now be piled on the top of each other, and be left between two boards under a weight, or better, in a letter-press, for a few days, when, if the surface of the paper has not been high, they will be found to be sufficiently flat and will remain so. If, however, the paper has been one of very high surface, it will tend to curl towards the albumenised side even after the prints have remained for a very long time under pressure. To render such prints flat, the best plan that I know of (next to rolling them in a machine) is to roll them, just after they come from the drying boards, tightly on a small roller, albumenised surface outwards. One print is rolled tightly round the roller, which may be about 1 inch in diameter, the end of the next print is caught under the end of the first, and it is tightly rolled up, and this process is continued till any number of prints up to about twenty are rolled on the roller, a book-wrapper is then rolled up to make an outside covering, and the roll is put on one side for a few days, or till the prints are required.

There are other methods of drying prints besides placing them between drying boards. Thus they may be blotted off and laid face downwards on drying boards or sheets of pure white blotting-paper. In this case they are rolled up, albumenised surface outwards, as just described, whenever they curl so far that further curling would mean a tendency to unmanageableness. This method is a good one for prints from whole plates or larger.

In the case of very large sizes it is sufficient to lay the wet print across a wooden roller, albumenised side outwards, till it is all but dry, then to roll it up as described above. Some again place the prints face downwards on a string net, then place another net over them so as to prevent them from curling as they dry.

Here let me insert a remark which might as well be inserted in almost any other place. Let the beginner who, on first attempting some apparently very simple manipula-

tion, finds he has some difficulty in succeeding — if, for example, he tears his prints in attempting to roll them up — not conclude that the directions given him are necessarily wrong, but consider that possibly a little practice is required on his part.

CHAPTER VII

SILVER PRINTING—*continued*

Albumenising Paper

MENTION has already been made in the introductory chapters of albumenised paper. The advantage of paper coated with albumen, as it is in these days, is that a glossy surface is produced which gives a depth and transparency to the shadows, and a delicacy to the high lights which cannot be attained without some gloss, and that a great range of very beautiful tones are obtainable. It is quite true that many—and amongst them those who have a right to be considered authorities on the artistic side of the question—object to the glossy surface of albumenised paper very strongly; and, further, that a great deal of the want of permanency of silver prints is probably due to the presence of the albumen. Still the fact remains that at the date of writing the albumen process is still the favourite, and that probably nine out of every ten photographic prints are produced by it. Indeed, so much more is it used than other processes employing silver that, when the term “silver printing” is used, it is generally understood to mean printing on albumenised paper.

Briefly speaking, the process is as follows:—Paper is coated with a solution of salt (chloride of ammonium generally, but sometimes common salt, chloride of sodium) in albumen, egg-albumen alone apparently being suitable. The paper is then floated, albumenised side downwards, on

a strong solution of silver nitrate, the result being that the albumen is "coagulated" or rendered insoluble in water, a double decomposition takes place between the silver nitrate and the chloride of ammonium in the albumen, silver chloride which is sensitive to light being produced; and further, an action takes place between the albumen itself and the nitrate of silver, an organic compound sensitive to light, to which the term albumenate of silver has been given, being formed.

It is usual in these days for the photographer to purchase this paper already albumenised, even if he do not purchase it ready sensitised as described in a former chapter. Albumenised paper is now so cheap and so reliable that there is no temptation to go through the very troublesome process of albumenising on a small scale. Still no book treating specially on silver printing would be complete without an account of albumenising paper, and for this reason I describe the process here.

First as to the paper. There are at the present day—in Europe at any rate—practically only two brands of paper that are ever used for albumenising—namely, Rive and Saxe. These are both very beautiful plain papers of great purity, evenness, and fineness of texture. They can be had of almost all dealers in this country. They are made in various thicknesses—the thickness being always expressed in terms of the weight of a ream (480 sheets). Papers from 8 to 12 kilo. are commonly used for albumenising, but none under 10 kilo. is to be recommended for any but small work, and I should certainly not advise any photographer who wants to experiment on albumenising to try anything lighter. He will find 10 kilo. Rive or 12 kilo. Saxe excellent for his purpose. The size of the sheets is about 22×17 inches, and, of course, on a commercial scale they are coated whole. It will, however, be well at first not to attempt anything larger than a quarter sheet at a time.

The albumen must be obtained by separating the whites of eggs from the yolks. This is done by cracking the shell across and letting the white run out from between the two

halves without breaking the yolk. The writer must, however, confess that, in the case of his own experiments in albumenising paper, he has always called in the assistance of one skilled in culinary operations for the breaking of the eggs and the frothing of the albumen to be described hereafter. Every egg will do for about two sheets of paper (with due economy somewhat more), but it must be borne in mind that there must always be a minimum quantity of albumen sufficient to cover the bottom of a dish somewhat larger than the paper to be floated, to a depth of at least quarter of an inch. This means about twenty eggs before a single quarter of a sheet can be floated. In separating the whites from the yolks of the eggs each white should be dropped singly into a cup, so that if the yolk by accident break and get mixed with the white, that egg only need be rejected in place of the whole of the whites already collected, or at any rate the very large quantity of the albumen that it would be found necessary to waste before every trace of the yolk is removed. It must be understood that no speck of the yellow of the yolk must be allowed in the albumen.

The next question is as to the quantity of salt that it is well to use. Thirty years ago it was common to recommend a very large quantity—20, 30, or even 40 grains to the ounce being mentioned. Very much less salt is now, however, commonly used. I think I may pretty safely say that no commercial albumenised paper is salted with more than 10 grains of chloride of ammonium (or the equivalent in some other chloride) to the ounce, whilst I know that some of those which gave exceedingly brilliant prints with deep shadows, and which give better results with a strong silver bath than a weak have less than half that quantity.¹

From what I can gather, 8 grains to the ounce is a common quantity of chloride of ammonium used by commercial albumenisers.

For each ounce, then, of albumen that we have, we

¹ See chapters on "The Silver Bath" and on "The Chemistry of Silver Printing," in the latter of which is given a method of determining the amount of soluble chloride, which there is on a given area of paper.

take 8 grains of chloride of ammonium, which is dissolved in the smallest possible quantity of water, and is then added to the albumen. The quantity of chloride of ammonium necessary for 20 ounces of albumen may be dissolved in 1 ounce of water.

The albumen being "salted" has next to be beaten up into a very fine froth. An American egg-beater may be used, but it is common, when the process is conducted on a large scale, to use a bundle of birch twigs, the barks from which has been removed. In any case the "frothing" must be very thorough, otherwise streaks will be produced on the surface of the paper. When a very thorough froth has been obtained, the vessel containing the albumen (which, by the way, must be many times larger than is sufficient to hold the unfrothed whites) is placed on one side to settle. Probably it will be ready for filtering in about twenty-four hours, but it may be left for several days if desired. It is filtered before use through a couple of thicknesses of muslin.

When floating is to be performed the salted albumen is poured into a flat dish, as already mentioned, to a depth of not less than quarter of an inch. The two faults liable to occur in floating the sheets are air bubbles, which form spots, having on them neither albumen nor salt, and therefore, of course, practically unsensitisable, and streaks formed by unsteadiness in lowering the paper on to the albumen.

It is commonly directed to hold the paper by opposite corners, allowing it to bag or sag down in the middle, to allow it to touch the albumen along the line of the bottom of the sag, and then to lower the two corners simultaneously. I scarcely think, however, that this is the best way of working, as air bubbles are particularly liable to be formed.

It is somewhat difficult to describe methods of manipulation in writing, but I shall endeavour, by the aid of a couple of cuts, to make clear what I consider to be the best way of floating paper either on albumen or on a sensitising bath.

In both cuts C D is supposed to be the dish of albumen ; A B the sheet to be floated.

The operator stands at the end C of the dish, facing it.



Fig. 1.

The end A of the sheet is held in the left hand, whilst with the right hand the edge B is turned up as shown in Fig. 1, and is thus brought into contact with the albumen. The end A is then slowly and quite steadily lowered, whilst



Fig. 2.

the end B is, so to speak, pushed along the surface of the albumen till, just before the process is complete, the sheet assumes the form shown in Fig 3.



Fig. 3.

It is well not to have the paper excessively dry before floating, otherwise it will have a strong tendency to curl away from the albumen at the edges. If it have been kept

for a few days in a cellar of not extraordinary dampness, it will probably be in good condition. Should it nevertheless curl away from the albumen, it may be made to lie flat by gently breathing on the back of it; but the best plan is to have some little blocks of wood, say 2 inches $\times$ $\frac{1}{2}$ inch $\times$ $\frac{1}{4}$ inch, to lay on the back of the paper and catch the curling edge, as shown in Fig 3, where A and B show the little blocks.

At the end of about a minute, or whenever the tendency to curl is over, if the time required be more than a minute, the paper is taken by two adjacent corners, and is drawn with an even motion off the albumen. It is then hung up to dry, by placing it, albumenised side outwards, across a roller of wood of such a thickness that there is no tendency to fold. Two inches or so is about the best diameter for the rollers. The paper should be placed in a warm and well-ventilated room to dry. The warmth is especially necessary if a high gloss be desired. Indeed, in this case, a temperature of 80° or even more is not at all too great.

The paper in drying tends to curl towards the albumenised side. It may, when quite dry, be straightened by rolling it up in the manner already described for prints,¹ but as, on account of the difficulty there is in afterwards floating albumenised paper which has been rolled up, it should, in the writer's opinion, never be rolled up at all,—that is to say, till after it is sensitised. The sheets may be laid face downwards and carefully flattened out one at a time by hand, one being placed over another, and eventually a board may be placed on the pile with a weight on the top.

In working on a large scale albumen may be purchased from egg merchants, who dispose of the yolks of eggs to confectioners,² or the eggs may be purchased, kept a few days and cracked, and the yolks may be sold to the confectioners.³

¹ See Chap. VI. p. 55.

² Abney and Robinson's *Silver Printing*.

³ George Dawson, *British Journal of Photography*, September 10, 1886.

It is customary in this country to use fresh albumen ; but the smell of some foreign papers proves conclusively that the albumen used is not fresh, and these papers sometimes give particularly fine results. The gloss is very high, the prints are exceedingly rich, and tone to an excellent colour. It is commonly supposed that these papers are floated on putrid albumen, but the writer feels convinced that this statement is not strictly correct. That the albumen has undergone some decomposition appears certain, but that it is not a decomposition analogous to putrefaction appears from the fact that the smell, although disagreeable enough, is very different from the well-known "rotten eggs " smell. Moreover, the writer's experiments with albumen simply allowed to get putrid have resulted in something in no way approaching the samples of albumenised papers already referred to.

I have been told by Otto Schölzig that the result is produced by *fermenting* the albumen, which is an altogether different thing from allowing it to become putrid. I am, however, unable to give any details of the process.

If it be desired to give a tint to albumenised paper, a little colour is introduced in the albumen, enough to give the desired tint. Aniline colours are commonly used. I have been told by W. Ashman that Judson's dyes answer very well.

Double albumenised paper is produced by floating each sheet twice on the albumen. To prevent the coating acquired by the first floating from being dissolved off on floating a second time, it is necessary to coagulate it. This is usually done with damp heat by the aid of steam, but I believe that alcohol is now commonly used. At any rate it is quite efficient. The sheets being once floated and dried, are floated on, or dipped in a mixture of 4 parts of methylated spirits to 1 of water. To float on this is difficult, and I advise that any one, experimenting in this direction, dip the sheet entirely, although thereby there is some waste of spirit. The paper is once more dried and is then floated a second time.

It is not necessary that the albumen for the first floating

be salted at all.¹ Indeed, there would appear to be a distinct advantage in not salting it, as thereby the image is kept entirely on the surface of the paper, which is one of the chief objects in double albumenising. I am aware, however, that in some excellent brands of double albumenised paper both coatings of albumen are salted.

Much of the paper sold as double albumenised is in reality only single albumenised. This can readily be proved by placing a piece of it in cold water, when all the albumen will be washed away, showing that there is no film of coagulated albumen.

¹ George Dawson, *British Journal of Photography*, September 10, 1886.

CHAPTER VIII

SILVER PRINTING—*continued*

The Sensitising Bath

THE so-called silver bath or sensitising bath for albumenised paper is simply a neutral solution of nitrate of silver.

The strength of the solution is of some importance. In the very early days of silver printing, baths of what would now be considered enormous strength were used. Some twenty years ago there was a reaction, and baths of very great weakness were the fashion. A happy medium appears now to have been struck, and there is no reason to suppose that it will soon need to be departed from.

It is customary to state the strengths of sensitising baths in terms of "grains to the ounce," the meaning of this being that there are so many grains of the silver nitrate contained in each ounce of the sensitising bath. This is certainly far from being a scientific manner of stating strengths of solution, but as, in the case of a sensitising bath, a small percentage of error has no perceptible influence on results, and as most photographers are still more accustomed to manipulate grains and ounces than grammes and cubic centimetres, I give strengths in grains and ounces.

The older formulæ for sensitising baths used to give quantities up to 120 grains to the ounce. The weak baths of the period of reaction went as low as 20 grains to the ounce, or, I believe, sometimes even lower. At the present

day it is customary to recommend strengths of bath from 40 to 60 grains to the ounce.

The bath ought, according to certain theories, to vary somewhat with the amount of salt used in the albumen, with which the paper is coated, being stronger the greater the quantity of salt; but I must confess that, working within the limits of salting now common, and within the limits of sensitising bath just mentioned, I have not found any appreciable benefit to arise from varying the strength of the sensitising bath with the amount of salt in the paper. On the contrary, I have sometimes found that a comparatively strongly salted paper gave a better result with a 40-grain bath than with a 60-grain, and a comparatively weakly salted paper a better result with the stronger bath.

The best course to pursue in determining at what strength to work is, I think, to take the word of the albumeniser as to the strength of bath that it is best to use, bearing in mind that, whatever he says, it is probably best never to go below 40 grains, whilst it is never necessary to go above 60,—that is to say, for the ordinary run of work. I shall have a word or two to say afterwards on variations of the bath for what may be called abnormal negatives.

If the albumeniser be unable to give any decided opinion as to the best strength of the bath, or, indeed, in any case if much paper requires to be sensitised, it is advisable to settle the matter experimentally by sensitising small pieces of paper on each of three experimental baths made up respectively to 40, 50, and 60 grains to the ounce, printing each under the same negative—one of good standard quality—finishing the prints, and comparing the results.

The strength of the bath being determined, there need be no difficulty in mixing it up. If distilled water be at hand it is well to use such; but if time be given, for the precipitate which is formed to settle, any tap-water, of not more than ordinary impurity, may be used.

It is a good thing to have a larger quantity of silver solution than is absolutely necessary to cover the bottom

of the sensitising bath. I advise, for whole sheets, not less than a gallon, and a smaller quantity in proportion to the size of smaller dishes. For reasons mentioned hereafter it is advisable to have much more solution even than that mentioned if, as is the case in very large establishments, the sensitising is a continual and daily process.

The bath once mixed up is ready for use immediately, if it has been made up with distilled water; if tap-water has been used, after the precipitate which has been formed has had time to subside, the *bottle containing the solution remaining during the subsidence in bright sunshine if possible.*

So far all is easy; but a bath is liable, after use, to deteriorate in various ways. Thus, for example, a certain amount of the solution is licked up by every sheet floated; but more than this, the remaining solution is left somewhat weaker after every operation. Then, again, a certain amount of organic matter is dissolved by the bath from the albumen of the paper used; still further, there is, at times, a tendency on the part of the bath to become acid, which results in a fatal deterioration in the quality of the paper sensitised on it.

To check the tendency on the part of the bath to become weaker, it is necessary to add a little silver nitrate from time to time. The best way in which to do this is to keep a stock solution of a strength twice that of the bath. A solution of 100 grains to the ounce, for example, for a 50-grain bath, and to add at the rate of quarter of an ounce of this for every sheet sensitised. If a very small quantity of bath (say only 1 pint) be used, the strong solution should be added (quarter of an ounce) after a single sheet has been sensitised. On the other hand, if there be a gallon of solution, it is sufficient to add to it (2 ounces) after the sensitising of every eight sheets.

The quantity of silver nitrate just mentioned will, if regularly added, keep both the strength and the amount of the bath fairly uniform, but there will still be a slight residuary variation. Probably both the strength and the quantity will slightly decline. In any case it is necessary to make an estimation of the strength of the bath from

time to time. Certainly an estimation should be made after a quire of paper has been floated on each pint of solution. It were better to perform the operation oftener.

Instruments entitled argentometers are sold for the purpose of estimating the strengths of silver baths. They are simply hydrometers rather roughly made. They are floated in a little of the sensitising solution placed in a small, tall jar, and the strength in grains to the ounce is at once read off on the stalk of the argentometer. These are very useful instruments for estimating the strengths of newly-prepared baths; but I must say at once that, for estimating the strength of a bath which has been much used, and which contains a large quantity of nitrate of ammonium, or rather soluble nitrate in it, besides the nitrate of silver, the argentometer is absolutely useless. The only method to pursue is the volumetric method, and I wish to emphasise this strongly—by following instructions it is perfectly easy for any one, even absolutely ignorant of chemistry, to make a volumetric estimation exact enough for the requirements of a sensitising bath, and he who will not go to the trouble of making such may at once give over all idea of working with anything like the highest success or with uniformity.

The necessities for an estimation, quite nice enough for our purpose, are a burette holding 1000 grains of water, and a pipette holding 1 dram. A burette is simply a graduated tube, with a tap at its lower end, the zero being near *the top*, so that the quantity *run out* is read, not the quantity left in the tube. The burette is fixed so as to stand vertically. The pipette is a glass tube with an enlargement blown on it. It is drawn to a finish point at one end, and there is a mark on the portion of the tube between the enlargement or bulb and the end not drawn to a point. The pointed end is placed in any liquid, and the liquid is sucked up to the mark by applying the mouth to the other end. The result is that we have a small quantity of liquid very precisely measured off. The upper end of the pipette is stopped with the finger. By this

means the liquid is retained in it till the finger is removed, when it will flow out into any vessel at will.

The following solutions are now prepared :—

A {	Distilled water	20 ounces
	Bromide of potassium	82 grains
B {	Water	1 ounce
	Chromate of potassium.	10 grains

As some have apparently a strong, and to me quite unaccountable, prejudice against the use of the chromate as an indicator, I here state that it is by no means absolutely necessary to use it, and this for the reason that, when strong solutions are in question, the insoluble silver haloid is thrown down in a thick flocculent state, especially when silver is in excess, leaving the supernatant fluid nearly quite clear. It is, therefore, possible to observe when all the silver has been precipitated from the nitrate simply by observing when precipitation ceases. The use of the chromate is, however, so very easy, and it makes the ending of the precipitation so very clear and unmistakable, that I strongly recommend it. I give 10 grains to the ounce as the strength of the solution. But there is no need that it should be of this precise strength. It is sufficient to put a few small crystals of the chromate into a little water.

When it is desired to make an estimation, a dram of the bath solution is taken from the bath by means of the pipette and is placed in a white vessel—a teacup does excellently—about an ounce of water is poured over this, and then 1 drop of B solution. This 1 drop will probably turn the solution bright red. If it do not, more of the solution must be added drop by drop till the mixture is clearly red, but no more than is necessary to produce a distinct red colour must be used.

The burette is filled up to the zero line with A solution, and the tap being opened, the liquid is allowed to pour into the cup with constant stirring. It will be observed that, as the solution from the burette touches the liquid in the cup, the red colour is discharged, but as stirring goes on it

returns ; when, however, a certain point arrives, the return is very slow. The tap of the burette must now be half closed so that the solution only drops into the cup. Immediately that the red colour has been permanently banished, the tap is closed, and the number opposite the surface in the burette is read off, bearing in mind always that the numbers read downwards. Each ten figures now read 1 grain to each ounce of bath, each one figure $\frac{1}{10}$ grain. Thus if we read off 475 on the burette, it means that the strength of our bath is 47·5 or $47\frac{1}{2}$ grains to the ounce, and so, if it had originally been of a strength of 50 grains to the ounce, it requires strengthening by $2\frac{1}{2}$ grains of silver nitrate to each ounce.

The process, as described in writing, seems complicated, but it is far from being so. The writer has seen a girl go through it entirely by rule of thumb within a couple of minutes at the end of a day's sensitising.

There is a still simpler method of finding out, not the precise strength of a bath, but whether it is up to or above a certain standard. All that is wanted in the way of apparatus is a small pipette. The exact size does not matter. The smaller the better, as there is less of the silver bath wasted in the testing.

A standard testing solution is made up of 7 grains of bromide of potassium for every 10 grains of nitrate of silver in the sensitising bath when up to standard. Thus if it be desired to keep the bath at 50 grains to the ounce, the testing solution is to be made up to 35 grains.

The fill of the pipette of the testing solution is poured into a white vessel, and over it some twenty or thirty times as much water as the pipette holds, and a few drops of the chromate of potash solution. The pipette is thoroughly cleaned, and is refilled this time with the bath solution, which is now allowed to pour drop by drop into the white vessel with constant stirring. As each drop touches the surface of the liquid a red stain is produced, which, however, at first quickly vanishes with the stirring, but after a time more slowly. At a certain point the red discoloration refuses to go at all. If this point is reached

before the pipette is empty, it proves that the bath is *more than* up to strength. If a few more drops of silver solution have to be added before the red colour becomes permanent, this *proves that the bath requires strengthening*.

After some practice it is easy to guess pretty well how much too strong or too weak the bath is, but, of course, the method can by no means be termed an exact one for determining anything beyond the fact that the bath is too strong or too weak, or is of the normal strength.

Next as to the tendency of the bath to become acid. Fortunately there is a very easy way of preventing this. It depends on the fact that carbonate of silver is insoluble in water or in a solution of nitrate of silver, but that almost any acid will replace the carbonic acid of the carbonate, freeing the latter acid in the form of carbonic acid, in which form it is free to escape, and producing a neutral salt. Or, as it is commonly put, carbonate of silver is insoluble in water, but is soluble in an acid, neutralising it. It is from this evident that if we have carbonate of silver in our bath, it will remain as an insoluble and innocuous precipitate so long as the bath is neutral, but will at once be used up in neutralising any acid which may be introduced.

If a solution of carbonate of potash or soda be added to a solution of nitrate of silver, the result is to throw down a precipitate of carbonate of silver. All that we have to do then to keep our sensitising bath neutral is to pour into it from time to time a few drops of a solution of (say) carbonate of soda, so that there is an appreciable amount of precipitate at the bottom of the stock bottle, and from time to time to shake up this precipitate and allow it to settle again.

Fortunately the carbonate of silver also forms a medium for the precipitation of organic matter which may be dissolved in the sensitising bath. If such a bath be "sunned,"—that is to say, be placed in a bottle of blue or colourless glass in a bright light,—the organic matter will be oxidised so long as the solution is not acid, a black, dirty-looking powdery deposit being the result. If there be present in

the solution carbonate of silver in a fine state of division, this, in settling down, will carry the oxidised organic matter with it.

To keep our bath free from both acid and organic matter, it is then only necessary to keep always at the bottom of the stock bottle an appreciable amount of carbonate of silver (produced by pouring a little carbonate of soda into the solution), and occasionally to shake this up with the liquid, and place the latter in the brightest light available, pure sunshine if possible.

When, after the bath has had a good deal of use, and the deposit of carbonate of silver and organic matter assumes the form of a black mass, the solution should be filtered, the filtrate being, of course, added to the silver residues.

In those cases where sensitising goes on from morning till evening, as in some very large establishments, it is advisable to have at least one bath in work and one at rest in the sun. I know, at any rate, one case in which a sensitiser keeps a number of baths continually going, and for each at work keeps two at rest.

Working baths as I have described, I believe that there is no reason why a bath should ever break down altogether. It is true that there is a certain accumulation of soluble nitrate other than the silver nitrate (generally nitrate of ammonium) in the bath, but after a time this reaches a maximum beyond which it will not pass, and, so far as I can judge, even when this point is reached, the bath works as well as when new. A method will, however, be given farther on of precipitating and redissolving a bath should it for any reason refuse, even after the treatment described, to give good results.

CHAPTER IX

SILVER PRINTING—*continued*

Floating and Drying Albumenised Paper

THE “silver bath” has been already described, and directions have been given for making it and keeping it in good condition. All that remains is to describe the method of sensitising the albumenised paper, or of “floating,” as it is commonly called.

In the first place, as regards the condition of the paper before it is laid on the surface of the bath. It should not be exceedingly dry, otherwise difficulty will be found in causing it to lie flat on the surface of the bath. It is a common thing to advise that the paper be kept in a damp cellar for several hours, or even a day or two, before it is floated. There can be no doubt that if this advice be taken, the paper will be in the best possible condition for floating after it comes from the cellar; but it is not every one who has the use of such a place, and in any case it is a somewhat cumbrous manner of damping. The way in which the writer has performed this operation is as follows:—The paper to be floated is placed on a shelf of any cupboard that can be devoted to the purpose—of course, where much paper is manipulated, it will be a small affair to construct such a cupboard—and under the shelf, on the floor or bottom of the cupboard, is placed a dish or bowl of boiling water. The steam or vapour soon diffuses through the whole of the cupboard and slightly damps the uppermost sheet of the paper on the shelf. The paper

requires to be laid face downwards, otherwise it is liable to curl up. As the operation of floating goes on, the hot water in the dish may be renewed every half hour, or as often as may appear necessary to keep the top sheet of paper always a little damp.

It is to be understood that no artificial damping—either in a damp cellar or anywhere else—is absolutely necessary for albumenised paper before it is floated. It is only to be considered that if damping be not resorted to, the trouble of floating will be greatly increased.

The size of paper that is to be floated is a matter for some consideration. As a matter of course, where printing is performed on a large scale, a whole sheet, measuring about 22×17 inches, will be floated at once; but when only a comparatively small quantity of paper is needed for printing, the first cost of dishes of the size necessary to permit of the floating of a sheet 22×17 , and of the solution necessary to fill such dishes, may be considered excessive.

Those who print on a comparatively small scale, and who therefore incline to float smaller than whole sheets at a time, should be regulated by the possibility of cutting the paper up into useful sizes after sensitising in their choice of a size. It is to be borne in mind in this connection that it is always less wasteful to trim something off the paper before sensitising than afterwards. Thus, if the size to be worked be 10×8 , and it be decided to float pieces which will cut into two prints of that size, it will be seen that only two pieces for floating can be got out of half a sheet. But the size of a half sheet is about 17×11 , whereas all that is wanted is 16×10 , or even somewhat less than that if we consider that it is seldom possible to print quite up to the edge of a negative. It is therefore an economy (although it results in the waste of some albumenised paper) to trim an inch off each of two edges of the half sheets.

It is a common custom with dealers to send out small quantities of albumenised paper in the form of a roll. There is no objection to this so long as the paper is not to

be floated in sizes larger than about quarter sheet ; but if it be intended to float whole or even half sheets, the difficulty will be enormously increased if the paper has been rolled up. The operator should therefore be careful to ask that the paper be sent out flat. It always is so sent out when any considerable quantity is purchased.

Concerning the actual action of floating I cannot do better than refer to the chapter on albumenising. The paper may be floated on the silver bath in precisely the same way in which it is floated on the albumen (see Chapter VII.) There are also the same precautions to be taken in preventing it from curling up on the surface of the liquid, so that the edges turn on to the back of the paper, and to discover the presence of air bubbles. The paper should not, however, curl away much from the liquid if it have been damped as described, and air bubbles are much less liable to occur when the bath is kept free from organic matter than when it is not.

After the paper has been floated for about half a minute, or till such time as the tendency to curl ceases, it is lifted to see if any air bubbles adhere to it. If they do, they are caused to creep to the edge by laying the paper down on the bath very slowly, or, if this be found impossible, they are broken by the aid of a quill or a glass rod.

The time of floating is one to which it is necessary to give some attention. The time necessary to convert the whole of the salt of the paper into chloride of silver, and also to form an organic compound with the albumen, varies considerably with circumstances. Thus it varies with the strength of the silver bath, but it sometimes comes about that a strong bath requires a *longer* time of floating than a weak one. The reason of this is that nitrate of silver has the effect of coagulating albumen—otherwise soluble in cold water—and that if the bath be very strong in silver nitrate, the coagulation of the surface is very rapid, and considerable time is required for any solution to penetrate the nearly impermeable film thus produced. The conditions are, however, very complex, and it is not at any time possible to tell for certain whether strengthening the bath

may necessitate a longer or a shorter time of floating, especially as one item to be considered is the amount of salt in the film which determines the quantity of silver nitrate which must penetrate the surface of the film.

Again temperature greatly influences the time taken for floating. Most chemical reactions proceed more rapidly at a high than at a low temperature, and the sensitising of paper is no exception to the rule. When I say that with a 50-grain bath, with the average of papers in the market, and with a temperature of 50 or 60 degrees, three minutes' floating will give an excellent result, the statement cannot be taken as an absolute, but only as a general one.

It is very easy, however, to make a test to discover when the sensitising is complete, and as this test once performed the operator may give continually the same time of floating so long as the conditions remain constant, and be assured that he is giving the best length of time, I think it a pity that a printer should ever start sensitising under new conditions without making such a test.

All that is necessary for the test is a solution of a few grains of chromate of potash to an ounce of water, and a small hair-pencil, with which a little of this solution may be brushed on to the back of a sheet of paper.

A drop of the solution is brushed on to the very corner of the first sheet to be sensitised, or is brushed on to the centre of a small piece of albumenised paper devoted entirely to the test.

The chromate of potash is yellow, and makes a lemon-coloured stain on the back of the paper; after a minute or two, however, this stain begins to darken, proving that free silver nitrate has penetrated the albumen film, and is combining with the chromic acid of the chromate of potassium to form chromate of silver, which is of a deep red colour.

The spot will eventually become quite deep ruby in colour, but it may be taken that, when it has acquired an orange colour, the sensitising may be looked on as complete. The time occupied between the floating of the paper

and the change of colour of the spot to orange is observed, and this is the right time for floating.

The floating complete, the paper must be removed from the bath, and it is desirable to remove it so that it takes as little as possible of the bath solution with it. There are two ways of accomplishing this. One is to draw the sheet over a glass rod placed across one end of the bath; another method, and one better, although it occupies more time, is simply to lift up the paper very slowly, which method will give as good a result as can be got in the way of economy.

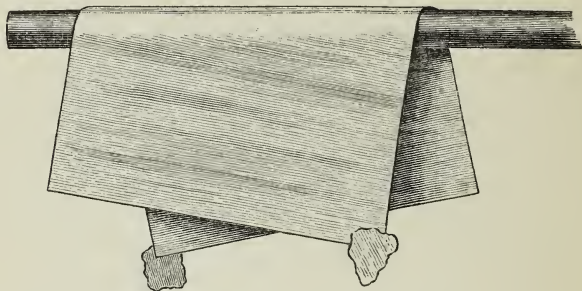
The paper is next hung up to dry. No special application of heat is necessary in drying, but the room in which the operation is performed—which may be the same as that in which sensitising goes on—should be well ventilated, and should never be allowed to get very cold. In fact, the temperature should never be allowed to fall below 50° F. There is no objection to an open fire in the room. Indeed, it is rather an advantage than otherwise.

When paper is sensitised in large pieces—half a sheet or larger—it is best to hang it over rollers or thick cords, with the albumenised side outwards, to dry. When it is in smaller pieces than half sheet, it is liable to curl up so strongly in drying as to fall off the cord altogether. In this case it is best to hang it up by one corner either by a pin to the edge of a table, shelf, or other board, or to a lath, or to hang it (also by one corner) to a line by an American clip.

It is a question whether or not the paper should be “blotted off” before it is hung up, photographers differing somewhat on this point. The writer’s opinion is that there is great convenience in so doing, at any rate if the following instructions be attended to, even if it only be from the saving of trouble that arises from having a number of sheets or pieces of paper hanging up all at different stages of dryness, and any one of them requiring at any time to be attended to, to prevent it from curling up into a perfectly unmanageable state, as is the case when the sheets are hung up just as they come from the bath.

Either drying boards (already described) or sheets of blotting-paper guaranteed chemically pure are used. The size should be somewhat over that of the paper to be sensitised.

The sheet, as it comes from the sensitising bath, is laid face downwards on a sheet of the blotting-paper, another sheet of blotting-paper goes on the back of the sheet of sensitised paper, another sheet of sensitised paper (face downwards) on the top of this, and so on till the sensitising is done. A board and weight is then laid on the top of all for a few minutes, and the sheets are taken out—the pile having first been turned upside-down, so that those last



sensitised get a little longer blotting than they otherwise would—after which it will be found that they are but slightly damp. They are then hung up either over rollers or by the corners as already described.

It is to be noted that in the case of paper of very high surface blotting off is almost necessary, as otherwise the liquid runs into drops, or, as it is generally said, into “tears,” which leave spots printing darker than the rest of the print.

The blotting boards may be used over and over again till they refuse to act properly, when they are placed amongst other silver residue.

If the operator object to blot off, he may hang the sheets up to dry immediately that they come from the bath, in which case a small fragment of blotting-paper

should be caused to touch the lower corner or corners of the paper. This will absorb some few drops of bath solution which would otherwise drop on to the floor. When a piece of paper is hung over a roller—unblotted—it should be hung somewhat on the “skew.” This will have the result of causing the liquid to flow to two corners, to which are applied the pieces of blotting-paper. The accompanying sketch will explain what is meant.

The paper, whether it has been blotted off or not, must, after it has dried so much that it begins to curl badly, be treated in some way to flatten it, or at least to make it manageable. It is the custom with some to lay the sheets on the top of each other in a pile with a weight on the top; but this operation is difficult, and leaves a mass of paper not quite dry, and in such a form that it will not speedily become quite dry.

The writer has succeeded best by rolling the paper albumenised side outwards on a roller, causing the beginning of one sheet to lap under the end of the one that is to come next, as already described for albumenised paper. Twenty sheets or pieces are so rolled up with a piece of plain, or still better, albumenised but not sensitised paper round the whole.

I must not omit to describe a method of rendering sensitised paper manageable.

The paper, dried so far as is possible without its becoming unmanageable, is rolled within a continuous roll of plain paper. The operation is performed in the following manner:—

A continuous roll of any ordinary white paper, somewhat broader than the sheets to be sensitised, is procured. The end of this is rolled on to a wooden roller for a few turns, then a sheet of the sensitised paper is laid face downwards on that portion of the plain paper which lies between the two rolls, and the rolling on to the second roller being continued, the sensitised paper is carried in with the continuous roll of plain paper. After all the paper has been passed into the roller, and the whole has

stood for an hour or two, the continuous paper is unrolled, and the sensitised sheets, as they come out, are laid in a pile. The continuous paper should be thoroughly desiccated after each operation by rolling it from one roller to another in front of a hot fire.

CHAPTER X

SILVER PRINTING—*continued*

Printing, Toning, Fixing, etc., of Paper Sensitised on a Neutral Bath

THE printing of paper prepared at home on a neutral bath is performed in precisely the same way as is printing on preserved paper; but it will generally be found that the process proceeds rather more slowly, and that, moreover, the printing must generally be carried slightly further, as prints on ordinary paper lose, as a rule, a little more than do prints on preserved paper. It is, moreover, to be observed that when, as is sometimes the case in very dull weather, especially in London, the prints take a very long time in the frames, it is necessary to keep a piece of soda-steeped blotting-paper behind each, or otherwise they will be spoiled through the spontaneous darkening of the paper. It is usual to tone the prints on the paper we are speaking of, on the same day in which they are printed, but if they be replaced between the sheets of soda blotting-paper they may be left for some days. Paper once printed—and especially where no quite pure high lights are left—has less tendency to darken spontaneously than that which has not been printed.

The first thing to be observed in connection with the toning and fixing of paper sensitised in the ordinary way on a neutral bath is, that there is much more silver washed out of it in the washings before toning than in the case of, at any rate, by far the greater number of brands of ready

sensitised paper. It is for this reason worth the trouble to keep at least the first two washing waters for the sake of the silver they contain. For the same reason it is desirable to get the first two washings over as quickly as possible, there being a possibility that the whites of the prints will turn yellow if they be left for any length of time in a somewhat strong silver nitrate solution—especially if they be allowed to stick together.

Prints on home sensitised paper are generally, as they come from the frames, of a much bluer colour than those on preserved paper, indeed they are sometimes of so deep a blue or purple as to appear as if they were already quite deeply toned. And it is obvious that there would, in this case, be great difficulty in observing the change which takes place in the toning bath.

Very frequently the prints turn reddish during the washing; but if, during the first two or three changes of water, no change in the colour of the prints takes place, it is necessary to have recourse to some way of bringing it about. The simplest way in which to do this is to put a little common salt into the next washing water. A very little will do—about half an ounce to the gallon is sufficient.

It will be observed of paper prepared on a neutral bath that it is much easier with it to get a purple tone than with preserved paper. In fact, it may be said that, whereas a brown colour is most readily got with preserved paper, and is, as a rule, the best colour that can be obtained with it, a purple is most easily got with paper prepared on a neutral bath, and that this is generally the best colour that can be got. No special precaution is necessary, nor any treatment with soda, as in the case of preserved paper. The toning operation is simply pushed until the purple tone is reached. Indeed, in the case of many brands of paper, especially if sensitised on a fairly strong bath—say one of 60 grains to the ounce—the process may be pushed till an engraving black tone is reached.

If, on the other hand, it be desired to get a warm brown with this paper, the prints should be treated after

they have had three or four washings with a strong solution of salt. Several ounces of salt to the gallon of water may be used ; but at any rate a solution so strong must be made up that the colour of the image turns to a bright red.

It is probable that rather less gold will be used up by the home-made paper than by the preserved ; but the writer's opinion is that there is less difference than is commonly supposed. It is certain that the operation of toning goes on much more rapidly—that the print darkens more quickly ; but this is no proof that less gold is being used up.

After toning, the operations of washing, fixing, and again washing, are exactly the same as those described for ready sensitised or preserved paper.

It is to be understood that the same bath may be used for paper prepared on a neutral bath as for preserved paper ; but as the toning generally proceeds more rapidly, it may be desirable to add more water.

It should always be understood that the formulæ given for toning are to be taken as approximate only. The amount of salt—neutral or alkaline—added, such as borax, for example, is generally fixed only by rule of thumb, and may be varied considerably without producing any appreciable variation on the results. Again, as to the amount of water, or of dilution of the solution, this also can only be determined by experiment. It will be understood that the more dilute the solution the slower the action, that very quick action is to be avoided as it commonly leads to inferior tones, and that too slow action is to be avoided on account of the waste of time involved. If the strength of the solution be so adjusted that toning is complete in any time between about eight minutes and twenty minutes, the best results may be looked for.

CHAPTER XI

SILVER PRINTING—*continued*

Storing Paper Prepared on a Neutral Bath, Fuming, etc.

WHEN paper has been prepared, as described in the last chapter, it will not keep as well as the preserved paper sold by the dealers. In a certain comparatively short period of time it will, without the action of light, turn more or less dark. The time that it will keep without any special precautions varies greatly with circumstances. Thus the weather modifies the time greatly. In hot, damp weather paper will not keep nearly so long as in cool, dry weather. Again, the purity or impurity of the atmosphere has much to do with the length of time that paper will keep. For example, in the air of London paper turns dark more quickly than in the country, probably on account of the sulphur from the burning of coal. But the thing that has the greatest influence of all is the condition of the sensitising bath as regards purity. If this be much contaminated with organic matter there is little chance that the paper will keep good for more than twenty-four hours, if so long. Indeed, with all the conditions unfavourable, sensitised albumenised paper will not remain white for more than an hour or two.

On the other hand, with the conditions all favourable, but without any special provision for preserving it, such paper will remain white for a week or ten days. In the case of ordinary everyday work, in average circumstances, paper may be depended on not to discolour to a degree

which would make it useless in less than forty-eight hours ; but it is usual, when it is not preserved in any special way, to try to have the prints finished within twenty-four hours of the time when the paper is sensitised.

One of the older methods of preserving sensitised albumenised paper is simply to keep it quite dry, in which condition it will keep for weeks. To secure complete dryness it is necessary to use some deliquescent material, which is generally chloride of calcium. The paper is placed in a tin tube with an air-tight lid, or in any other receptacle which is both light-tight and air-tight, and in the same receptacle there is placed some dried chloride of calcium, care being taken that the salt is not allowed to come into contact with the paper, otherwise the latter will be destroyed. A particularly convenient form of tube is made by the Platinotype Company. The lid contains a receptacle filled with asbestos, which has been soaked in a strong solution of chloride of calcium and has been afterwards dried. There is air communication between the receptacle and the body of the tube through a perforated sheet of metal, but the perforations are so fine that the chloride of calcium is quite confined to its own compartment.

Paper that has been thoroughly desiccated, as in the calcium tube, must be allowed to absorb a little moisture before it is placed in the printing-frame, otherwise it will print poorly. It is sufficient to allow it to hang up for half an hour in any atmosphere not abnormally dry ; but the best plan is to fume with ammonia, by which operation the paper is certainly made quite as good as paper freshly prepared. The process of fuming will be described a little farther on.

The best way of preserving sensitised paper, in the writer's opinion, is to use soda-treated blotting-paper or drying boards.

A solution of carbonate of soda is made by dissolving 2 ounces or thereabouts of washing soda in each pint of water. Into this are dipped a number of sheets of blotting-paper, which are then dried and used as will be directed.

If, as is the case with some kinds of blotting-paper, it be found impossible to remove whole, unfolded sheets from the solution, because the paper has become so tender that it tears, the sheets may be doubled before they are placed in the liquid, and being removed folded in two, may be so hung up to dry over a line. Of course, in this case, the drying takes somewhat longer than when they are single.

The sheets, once dry, are ready for use, and may be used over and over again. As the paper is sensitised and dried—when it has reached the stage where it is just beginning to curl badly—it is placed between two sheets of the soda paper, and a pile is made of alternate sheets of soda paper and sensitised paper. A weight is placed on the top of all. Paper so treated will keep for weeks, indeed months. I do not know whether the action of the soda has ever been entirely explained, but I have heard it suggested that it acts as a “sulphur trap,” preventing sulphur from getting to the sensitised paper from the atmosphere. This theory finds some corroboration in the fact that contact between the sensitised paper and the soda paper does not appear to be necessary to ensure the keeping of the former. If, for example, a roll of sensitised paper be wrapped up securely in soda paper, it will keep white for several weeks.

Ammonia fuming of paper is a practice of many photographers, especially in America. The advocates of fuming hold that the practice results in more brilliant prints. That this is the case with some brands of albumenised paper is quite undeniable, and it may indeed be taken that every brand of albumenised paper will print at its best if, after sensitising and before placing in the frames, it is fumed with ammonia. Another thing that is equally certain is that it will print considerably quicker if fumed. Still further, any difficulty that there may be in toning—and especially in getting purple tones—will pretty certainly be lessened by fuming. The advantage of fuming appears to be greatest when the atmosphere is intensely dry. At such times it is found that inferior prints result unless some special steps be taken, and there can be no

doubt that one of the most effectual things to do is to fume. But there may be considerable doubt as to how much of the benefit is due to the ammonia—how much to the mere fact that the fuming of necessity somewhat damps the paper. It is probably because there never is intensely dry weather in England, whereas there frequently is, in some parts at least of America, that fuming is so greatly practised in the latter country, so little in the former.

The process of fuming consists simply in exposing the paper, after it has been sensitised and dried, to the action of the fumes of ammonia. Any arrangement which enables these fumes to act uniformly on the surface of the paper acts well. In America it is the custom to use drying boxes in which to dry the paper, and afterwards fume it. Any box or cupboard in which the paper can be hung up in separate sheets will serve the purpose of a fuming-box ; a saucer containing a little of liquor ammonia being placed in the bottom of it, and the paper being allowed to remain under the action of the ammonia for as long as is necessary to cause it to print in the frames to a deep and rich purple colour. The time taken will be from three to twenty minutes, according to various circumstances. Some paper requires more fuming than others. Again, the temperature modifies the time required, a shorter time being needed the warmer the weather. Further, as might be expected, the shape and size of the box influences the time required. The question is, however, easily settled by experiment. The paper must be fumed till it prints to a certain purple colour which, once seen, will always be recognised again. It may remain a very considerable time longer than is necessary to produce the desired result under the influence of the ammonia ; but it is possible to over-fume, the result being a dull, sunk-in appearance of the print.

The only danger to be guarded against is unequal action of the ammonia, which will produce, in the end, an inequality of tone. If the paper has been rolled up as recommended in the last chapter, or if it has been stored between sheets of soda paper, it may be hung up in the

drying box by laying it across rollers or pieces of stout cord with the albumenised side outwards, the lower corners being clipped together with American clips to stop the tendency that there is for the paper to curl towards the albumenised side.

Some operators wash their sensitised paper in order to preserve it. The result of washing is to remove the excess (or the greater part of the excess) of silver nitrate, which is the agent apparently most active in causing the paper spontaneously to darken. A little nitrate of silver must be left in the paper, otherwise brilliant prints cannot be produced even if fuming be resorted to.

The writer's experience is that it is difficult, or, indeed, practically impossible to strike just the right amount of washing necessary to leave the quantity of silver nitrate needed. Either the paper is washed too completely—in which case it will not print vigorously—or it is not sufficiently washed, in which case it will not keep much better than if it had not been washed at all.

It is, however, by no means difficult to wash and re-sensitise on a weak bath if the photographer likes to take the trouble and has enough of dishes and space to work them in. At least three dishes, besides that used for the first sensitising, are required. I shall call the dishes Nos. 1, 2, 3, and 4. No. 1 is the ordinary sensitising bath; No. 2 is a bath filled with clean tap-water; No. 3 the same; No. 4 is a silver bath made up to a strength of 4 or 5 grains of silver nitrate to each ounce.

The paper is floated on No. 1 bath as usual. It is then transferred to No. 2—being simply floated as before. A second sheet is now floated on No. 1. When the time allowed for sensitising is over, the sheet on No. 2 is transferred to No. 3, that on No. 1 is transferred to No. 2, and a new sheet is floated on No. 1. At the end of the next period the sheet on No. 3 is transferred to No. 4, that on No. 2 to No. 3, that on No. 1 to No. 2, and a new sheet is floated. Next time the sheet on No. 1 is hung up, the other three sheets each advance one stage, and so the thing goes on.

After there has been floated to the amount of ten or twelve sheets (17×22) for each pint of water in each of the baths Nos. 2 and 3, bath No. 2 is emptied into the residue tub, bath No. 3 takes its place, bath No. 2 is then filled with clean water, and takes the place of bath No. 3.

For example, if baths Nos. 2 and 3 each contain a gallon (8 pints), eighty to a hundred sheets may be sensitised before any change is made. The contents of bath No. 2 are then poured into the residue tub,—there will probably thus be at least 4 ounces of silver nitrate saved,—bath No. 3 takes the place of bath No. 2, another gallon of water is poured into bath No. 2, and it takes the third place. Bath No. 4 loses very little silver, but it does lose a little, and it must, therefore, of course, be kept up to strength. It should also be kept neutral like the sensitising bath—in fact, although its tendency to go out of order is very greatly less than that of the sensitising bath, it should be treated in precisely the same manner.

Paper prepared as described should keep white for some weeks if merely kept from light, moisture, and impure air; but it generally requires to be fumed before use. Without fuming, however, it does excellently for hard negatives, giving from such softer prints than are likely to be got from unwashed paper. Paper prepared as directed, by washing and sensitising, will keep better than paper only partially washed, even if the precise amount required be hit upon, because the nitrate of ammonium produced during the first sensitising is quite washed away. This nitrate of ammonium, the writer finds, has a great influence in aiding the spontaneous darkening of paper, besides retarding the printing to quite an appreciable degree.

It is to be observed that paper which has turned quite perceptibly brown through keeping may give prints with perfectly pure whites, the colour being discharged by the fixing bath. There is very good reason to believe, however, that the use of such paper leads to fading. More than thirty years ago Davanne and Girard discovered that, if a sheet of sensitised paper that has been kept carefully from light, but that has somewhat discoloured through

keeping, be fixed in a solution of hyposulphite of soda, there remains, although the paper turn quite white, a certain small amount of some silver compound, which the hyposulphite is incapable of dissolving away. The quantity was small, and the distinguished experimentalists conjectured that it would probably not interfere with the permanency of prints. The writer has, however, reason to believe that in some cases at least it may. He had the following experience some time ago. Prints were being made from a set of negatives, some of which were very hard. There was also on hand a considerable quantity of sensitised paper which had turned very brown. Thinking that paper browned by keeping would act in the same way as paper that had been "sunned," in the manner to be hereafter described, and having a view to economy, I used the discoloured paper for prints from the hard negatives. Prints that were quite satisfactory in appearance resulted, *but they began to deteriorate in six months*, the lighter parts yellowing badly. As these prints were prepared with all care except in the point mentioned, and as other prints made at the same time and treated in exactly the same way, except that the paper used was quite fresh, are still as good as new, I can only conclude that the deterioration is due to the fact that paper, the colour of which had turned, was used, and advise that if permanency be an object, such paper be entirely rejected.

CHAPTER XII

SILVER PRINTING—*continued*

Printing on Plain Paper

THE use of albumen as a coating for paper has for its object the production of a certain brilliancy and gloss not obtainable but by the use of some substance which keeps the image quite on the surface of the paper. That this gloss—or rather, perhaps one should say, the delicacy of detail which accompanies the gloss—is of advantage in the case of very small work can scarcely be denied; but the larger the work the less need is there for the gloss, and indeed many authorities, excellent on the artistic side of photography, hold that any gloss is distinctly inartistic and should be avoided.

However this may be, there can be no doubt that marvellously beautiful pictures may be made on plain, that is, unalbumenised, paper; and, moreover, that such pictures appear to be far more permanent than those on albumenised paper.

The writer has access to a large number of prints taken from thirty to forty years ago. There are some of them on plain paper, and some of them on albumenised; and, indeed, it may be said that there is every gradation between plain paper and what we now know as albumenised paper, because albumen was used in a very different way thirty years ago from that in which it is now used. A greater or less quantity of water was mixed with it, and the gloss

was accordingly less or greater—sometimes so slight as to be scarcely perceptible.

Of the prints referred to, it may almost be said that the fading has been proportional to the amount of albumen on the surface; and further, that of the prints on paper the most thoroughly albumenised, scarcely one is other than considerably faded, whilst of those on paper without any albumen at all few are faded perceptibly, except where they have been mounted on boards. When they are so mounted they have been affixed by the edges only, and these edges are badly faded.

The writer considers it a thing to be deeply regretted that the use of plain paper has gone so completely out of use as it has, and will feel that he has done useful work if his instructions are the means of making any photographer give the old process a trial.

As pointed out by Captain Abney, some idea of the results to be obtained by the use of plain paper may be gained by taking a piece of common albumenised paper and floating it face (albumenised side) *upwards* on the ordinary sensitising bath. The paper must be made distinctly damp before it is floated, otherwise it will curl very badly on the bath. After floating for the usual time, it is dried and printed with the back towards the negative, and is then toned in the ordinary way. If, as is quite likely, the operator finds it impossible to float it in this way, on account of curling, he may dip the paper entirely.

Saxe paper is well suited to the production of plain prints.¹ The following method of working has given excellent results in the hands of the writer. It is taken, with very slight modifications, from Hardwich's *Photographic Chemistry*.

In 20 ounces of water there are placed 20 grains of

¹ Some years ago—in 1887—the writer suggested the use of Japanese paper for the production of plane prints, and some results of great beauty have been got by some of his friends on the finer qualities of such paper. But, unfortunately, he is not, as yet, able to communicate any process which gives uniform results.

gelatine,—Nelson's No. 1 is suitable,—this is allowed to soak till it has swelled, when the water is heated to dissolve it. There are then added 60 grains of chloride of ammonium.

Saxe paper is soaked in this solution. The time of soaking does not much matter so long as the paper is allowed very thoroughly to soften, and care is taken that no air bubbles adhere to it. It is then allowed to dry—and here it is to be observed that, as the paper is not albumenised, there is not the trouble of continually guarding against its curling up in an unmanageable way.

This paper, when dry, may at once be floated on the ordinary silver bath used for albumenised paper. In this case the chromate test may be used for observing when the sensitising is complete. Very good results can in this manner be obtained, especially from very dense negatives; but the writer has got far better results—especially as regards colour—by using the “ammonia nitrate” bath, prepared precisely as recommended by Hardwich. By its means it is possible to get the richest imaginable purples. The following are Hardwich's instructions:—

“Dissolve 60 grains of nitrate of silver in half an ounce of water, and drop in ammonia until the precipitated oxide of silver is exactly redissolved.¹ Then divide this solution of ammonia nitrate of silver into two equal parts, to one of which add nitric acid cautiously until a piece of immersed litmus paper is reddened by the excess of the acid; then mix the two together, fill up to 1 ounce with water, and filter from the milky deposit of chloride or carbonate of silver, if any be formed.

“Ammonia nitrate of silver should be kept in a dark

¹ Liquor ammonia is dropped into the nitrate of silver solution. A black precipitate is at once produced; but as the addition of ammonia continues, the precipitate is redissolved. As the colour begins to lighten, the further addition of ammonia is very carefully made, with stirring after each drop is added. If the operation is carefully done, the “ammonia nitrate” solution will barely smell of ammonia.

place, being more prone to reduction than the nitrate of silver."

It is objectionable to *float* paper on an ammonia nitrate bath, as the solution is very liable to be contaminated by such floating, both by organic matter and by the salt of the paper, which causes the liberation of free ammonia, which, in its turn, marks the paper.

For this reason the paper must be damped with a brush. The writer has performed this operation in the following manner:—A sheet of the paper is pinned by the corners to a clean board. A broad camel's-hair brush, such as is sometimes used for damping the sheets of copying books, is used to brush the liquid over the paper.

The board is slightly inclined, and a liberal supply of the sensitising fluid being taken up by the brush is quickly drawn sideways along the upper edge of the paper. This operation is repeated, each sweep of the brush coming lower down, and when the whole of the surface has been damped, the brush, without further addition of sensitising solution, is used at right angles to the first lines of use; the board being, during this operation, inclined in a different direction from the first time, so that the brush always works in horizontal lines. The board is then placed horizontally for a couple of minutes, when the paper is removed from it and hung up to dry.

Plain paper prepared on the ordinary silver bath will keep just about as well as albumenised paper which has been sensitised; but prepared on the ammonia nitrate bath it keeps very badly. Indeed, if the soda-blotting sheets be not used, it will generally keep for only a few hours.

The plain paper is printed in just the same manner as albumenised paper. That prepared by floating on the ordinary bath will be found to print about as quickly as sensitised-albumenised paper. That prepared on the ammonia nitrate bath will print considerably more quickly.

Toning may be performed with the same toning bath as that used for albumenised paper; but the action will

take place more quickly in most cases, and for this reason it is generally advisable somewhat to dilute the bath. Probably about 1 grain of chloride of gold to 16 ounces of water will be found to give good results.

Fixing and washing are conducted in the same manner as with prints on albumenised paper.

CHAPTER XIII

SILVER PRINTING—*continued*

Various Toning Formulæ—General Remarks on Toning

THE number of toning formulæ, the use of which has been recommended from time to time, is very great. Many of these are probably merely fanciful variations of others. There are, however, certain formulæ which may be called "standard" formulæ, inasmuch as they have been used by great numbers of photographers for a considerable time, and have each of them adherents who swear by them.

In the historical sketch at the beginning of the book mention has been made of methods of "sulphur" toning, or toning without the aid of any gold at all. Such methods have not, so far as I am aware, any single adherent at this time, chemists having proved quite conclusively that the results of such toning must be very evanescent, and being in no way shaken in their conclusion from the fact that these results, in the form of very old sulphur-toned prints yet unfaded, appear to show proof of quite as much permanence as is to be found in many prints toned by the gold bath.

There are many prints in existence toned with hypo and silver upwards of thirty years ago, which have all the appearance of being as fresh as ever. It is quite possible, however, that this is really due to the fact that at the time referred to, it was the custom to use very dense negatives, a strongly salted paper, and a strong silver

nitrate bath, so that prints of great boldness with a very heavy silver deposit resulted.

The reader may, in any case, like to try a "sulphur" toning bath. This consists essentially of a hyposulphite of soda solution, with dissolved in it a certain quantity of hyposulphite of silver. This latter may be produced by dissolving iodide, bromide, or chloride of silver in the fixing bath, but it is difficult to see that these haloids can have any advantage over nitrate of silver.

The following bath, which is given by Hardwich, has worked well in the writer's hands; but as his experiments are only recent, he cannot give any opinion as to the permanence of the results:—

"Nitrate of silver	.	.	.	3 drams
Hyposulphite of soda ¹	.	.	.	4 ounces
Water	.	.	.	8 ounces

"Dissolve the nitrate of silver in 2 ounces of the water, then from the total quantity of hyposulphite of soda weigh out

"Hyposulphite of soda, 2 drams.

"Dissolve this likewise in 2 ounces of the water, and the remainder of the hyposulphite in the other 4 ounces. Then, having the three solutions in separate vessels, pour the nitrate of silver at once into the 2-ounce solution of hyposulphite, agitating the precipitated hyposulphite of silver rapidly. In a short time it will begin to decompose, passing from white to canary-yellow. *When the orange-yellow begins to verge towards brown* add the 4-ounce concentrated solution of hyposulphite, which will at once complete the decomposition, a part of the precipitate dissolving and the remainder becoming perfectly black. After filtering out the black sulphuret of silver, the solution is ready for use."

This bath will tone but slowly. It is, however, possible, if patience be exercised, to get a very fine black tone.

¹ The writer prefers to use only one-half this quantity of hyposulphite of soda.

The bath may be used over and over again, being only kept up to quantity with a plain hypo solution. Indeed, it improves by use, as silver is added to it by every print that passes through it.

It is advisable to fix the prints in a plain, neutral, or slightly alkaline fixing bath for quarter of an hour after toning.

Toning and Fixing in one Bath

The following formula for toning and fixing in one bath is taken from the *British Journal Photographic Almanac*. The writer has used it experimentally, and has got good results with it, but prefers to perform the operations separately :—

Chloride of gold	.	.	.	1 grain
Phosphate of soda	.	.	.	15 grains
Sulphocyanide of ammonium	.	.	.	25 „
Hyposulphite of soda	.	.	.	240 „
Water	.	.	.	2 ounces

The objection to the use of such a bath is that, after a few prints have passed through it, silver is dissolved by the hyposulphite, and may cause toning precisely as in the case of the bath last described, so that it is never possible to be sure how much of the tone given is due to gold, how much to sulphur. This is especially the case if the bath be used several times over.

The “Sel d’or” Toning Process

This objection does not hold in the case of the *sel d’or* bath now to be described. Although a small quantity of hyposulphite of soda is used, it forms a compound with the gold which is also used, and does not (the writer believes) form hyposulphite of silver with the chloride of silver of the prints.

The *sel d’or* bath was at one time a great favourite, and the substance *sel d’or* was an article of commerce. So far as the writer is aware, however, it is not now purchasable.

It is, however, very easily prepared. The following is the formula given by Hardwich :—

Chloride of gold	1 grain
Pure hyposulphite of soda	4 grains
Hydrochloric acid	4 minims
Water	4 ounces

The gold chloride and the hyposulphite of soda are each dissolved in 2 ounces of the water, then the gold solution is poured into the hyposulphite of soda (not *vice versâ*) slowly and with stirring. The hydrochloric acid is then added.

It is quite necessary when using the bath to get rid of all the free silver nitrate of the prints, otherwise the bath will be at once spoiled. This is effected by the use of common salt in one of the washing waters as already described (Chapter V. p. 43).

The bath acts quickly and gives good tones, which must be pushed pretty far, as there is generally a little falling off of colour in the fixing bath. This latter is made up in the ordinary way, but should be made so far alkaline with ammonia that it distinctly smells of this substance, so that the acid carried over by the prints may be immediately neutralised, or, what is better, the prints may be placed directly they are toned for a few seconds in a bath containing about a quarter ounce of ammonia to each pint of water. In any case the washing between toning and fixing must be very slight.

The Acetate Bath

The “acetate” toning bath is perhaps, in spite of various drawbacks, the most popular bath at this day, especially with professional photographers, and it is likely that in all cases where toning goes on regularly from day to day it is the best bath that can be used. For those, however, who tone only occasionally, it is inconvenient, as it has to be made up at least twenty-four hours before it is used, if the best results are expected. Indeed some hold

that an acetate bath should not be used till it is a week old. The formula is as follows:—

Chloride of gold	.	.	1 grain
Acetate of soda	.	.	20 to 30 grains
Water	.	.	12 ounces

The acetate of soda is dissolved in the water and then the gold is added. It is necessary to keep a considerable quantity of this bath in stock if it be decided to use it, for the reason that there must be enough to tone the largest batch of prints that is ever likely to be toned at one time. When toning is over the solution is not poured away, but is returned to the stock bottle, being, however, previously filtered. The necessity for this arises from the fact that, if any organic matter finds its way into the stock bottle, it is liable to precipitate the gold.

When the solution is returned to the bottle, about 1 grain of chloride of gold is added for each sheet, 22×17 , that has been toned, or if, even with this addition, the bath gradually loses strength, a little more than a grain.

The stock bottle should be kept in a dark place, as light is liable to cause a deposition and consequent loss of the gold.

The Gold and Phosphate Toning Bath

This bath is a favourite with many. It has the advantage that it may be mixed up just before it is required; but on the other hand, like most such baths, it will not keep. The formula is as follows:—

Chloride of gold	.	.	.	1 grain
Phosphate of soda	.	.	.	20 grains
Water	.	.	.	12 ounces

It is well in the case of both the last two formulæ to neutralise the gold solution before it is added to the liquid by adding a pinch of powdered chalk to it, and allowing the chalk to settle.

The Bicarbonate Toning Bath

It is usual to call the borax, the acetate, and the phosphate toning baths "alkaline" baths; but in reality the name is scarcely applicable, as the salts just mentioned are neutral or as nearly so as possible. The first toning baths were, as has already been mentioned, used without gold at all; next came gold mixed with hyposulphite of soda, then *sel d'or*, and after that an acid gold toning bath. This has not been particularly described, as there are many objections to its use. The next bath that was proposed was the alkaline gold toning bath,—namely, that in which gold was used in conjunction with bicarbonate of soda. This bath has still many adherents, and although, as I have said, other baths have been termed "alkaline," they should more strictly be termed *neutral*, the bicarbonate bath being the only true alkaline bath that I know of. The formula is as follows:—

Gold chloride	1 grain
Bicarbonate of soda	5 grains
Water	12 ounces

The bath is ready for use immediately that it has been prepared, but will not keep.

General Remarks on Toning

In each of the above formulæ I have given a certain definite quantity of water; but, leaving out of the question the hypo and silver fixing bath and the hypo and gold, the amount of water in every bath—including the *sel d'or*—should rather be fixed by experiment than taken as an absolute quantity. It must be borne in mind that some papers tone more readily than others, even if sensitised on a neutral bath, that preserved papers generally take longer to tone than those sensitised on a neutral bath, and that various scarcely understood variations in the toning bath cause differences in the time taken for toning. Now the thing to be aimed at in the composition of a toning bath

is that it should bring about the required change neither too slowly nor too quickly. It may be said that toning should never take less than eight minutes, and should perhaps take twice as long to get the best results.

In this connection I would lay great stress on a fact commonly left out of consideration. This is, *that the more gold actually used up in toning the better*, as there is the greater chance of permanency in the results.

As to this matter of permanency I would say a word. There are two different modes of fading ; or rather there is a fading, and another entirely different kind of deterioration which should not be called fading at all. The latter consists in a yellowing of the white of the prints. It is a thing very commonly met with, and gives a print an exceedingly disagreeable appearance. It appears to be brought about greatly by damp and sometimes by light. It is certainly due—at least when in at all an aggravated form—to the incomplete fixing of the image,—that is to say, to the imperfect removal of the last trace of the silver in some form or other, probably in combination with sulphur. The action of the fixing bath is to convert the compounds of silver, not acted upon by light, into hyposulphite of silver, which is insoluble in water but is soluble in excess of hyposulphite of soda. For the complete removal of the last trace of silver compound other than what forms the image, three distinct processes are therefore necessary. First, the whole of the silver compounds must be converted into hyposulphite of silver, requiring a certain quantity of hyposulphite of soda ; second, this hyposulphite of silver must be dissolved in an excess of hyposulphite of soda, which excess should be large ; and thirdly, the last trace of the hyposulphite of soda, containing the hyposulphite of silver in solution, must be washed out of the print.

To secure these objects, the use of an ample quantity of hyposulphite of soda is necessary, and the keeping of the prints in motion all the time they are in the bath, or, still better, the use of *two* fixing baths as already described. But something more is necessary, the baths must on no

account be acid, as the presence of any acid results in the formation of a silver compound insoluble in hyposulphite of soda—which silver compound is, I have not the smallest doubt, the most common of all causes of the yellowing of the whites of prints. I believe, indeed, that if prints were always carefully fixed in two baths, each containing a large quantity of a slightly *alkaline* solution of hypo, and were then fairly well washed, no yellowing need occur. Very complete removal of the hypo by washing does not appear to be necessary to prevent *yellowing*, the result of the presence of a trace of hypo being rather to prevent than to produce yellowing, but, on the other hand, to produce an actual fading of the image to be now described.

The image of the print before toning consists of some compound of silver. There is some doubt as to what this compound is;¹ but at any rate it appears to be something by no means very stable, for an image simply washed and fixed without being toned very soon fades, in the sense that the image is actually reduced in depth or intensity.

When, however, we tone the print, what is known as a “substitution process” goes on,—that is to say, a certain portion of the silver compound is replaced by metallic gold. Now gold is, next to carbon, one of the most stable of substances.

It therefore simply stands to reason that the more gold deposited on the image, or, to put it in other words, the greater the proportion of gold forming the image, the greater is the chance of permanency, whilst, could we replace the silver compound entirely by gold, we should have an image of a comparatively very high degree of permanency.

It may be asked why the toning process should not be continued till the substitution is complete,—that is to say, till the image consists of gold entirely, in a very fine state of division, in which form it may be of any colour from purple to red, according to the degree of fineness of the division of the gold.

¹ See Chapter XIV. “On the Chemistry of Silver Printing,” p. 102.

The writer is unable to say *why* it should be impossible to carry the process far enough for complete substitution, but the fact remains that before such substitution is complete the picture takes a sunk-in, disagreeable tint, and that, therefore, it is necessary to stop the process whilst there is still some considerable amount of silver compound in the image.

Still much may be done to keep the proportion of gold forming the image comparatively high. Thus it may be taken that whenever the toning proceeds very rapidly, the amount of gold deposited, by the time a certain tint is reached, is comparatively small, and the image, therefore, stands a correspondingly small chance of being permanent. Again the presence of free silver nitrate in the paper—as when it is but slightly washed before toning—accelerates, apparently, the change of colour without accelerating much the deposit of gold. In fact, it would seem as though the excess of silver nitrate acted in some way as a silver-toning agent, nor is this a thing at all absurd to suppose, if we consider the action of the hyposulphite of soda and silver toning bath.

It may be said, then, that we increase the quantity of gold required to produce any particular colour by washing out the silver nitrate from the prints as completely as is compatible with the gaining of the tone we wish,¹ and by toning slowly. By these means it is certainly possible to produce such a deposit of gold that the removal of all the silver compound scarcely appreciably reduces the depth of the image. This removal—or, what comes to the same thing for the purpose indicated, a bleaching—of the silver portion of the image is a thing very easily done, so that every photographer may readily determine for himself how much of the depth of the image of his silver prints is due to gold, how much to silver.

A saturated solution of bichloride of mercury is made up. If a print fixed, but untuned, be dipped in this, the

¹ With some toning baths and some samples of paper a purple tone cannot be got if all the silver nitrate be washed away from the paper.

image will entirely disappear. If, however, a very slightly toned print be dipped in the solution, some of the image will be left. In fact, just that portion of the image that is due to gold is left, whilst that which is due to silver is bleached till it is invisible. If the conditions have been such that as much gold as possible has been deposited, there may be a slight change of colour of the image, but there will be no perceptible reduction in intensity. In fact, there is a complete image in gold which, in all probability, is very permanent.

If the instructions given in a former chapter be carefully carried out, even a brown image may generally be made to consist of such a proportion of gold that it is not appreciably reduced by the bichloride of mercury solution.

Of all false photographic economies, the falsest would appear to be that which attempts to save on the amount of gold deposited on the image.

CHAPTER XIV

SILVER PRINTING—*continued*

On the Chemistry of the Image of Silver Prints

No work on printing would be at all complete without some few words on the formation of the image of a silver print. As, however, the writer does not pretend to any extensive knowledge of chemistry, he at once acknowledges his indebtedness to Abney and to Hardwich for the greater part of the information here given.

In all silver printing processes the silver is introduced in the form of silver nitrate ; but this salt itself is quite insensitive to light, as may be observed by the fact that it will, if pure, remain white for any length of time exposed to the strongest light in colourless glass bottles. In fact if, in the circumstances mentioned, silver nitrate discolour, this fact may, of itself, be taken as proof of the existence of some impurity in the form of some compound of silver, either organic or inorganic, other than nitrate of silver.

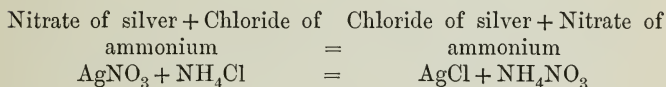
In all the silver printing processes yet described, the principal sensitive salt has been chloride of silver, a molecule of which may be supposed to consist of 1 atom of silver and 1 of chlorine, and is represented by the sign AgCl .

The relative weights of an atom of silver and one of chlorine are 108 and 35.5. If now we take of any salts, one containing silver and the other chlorine, such quantities that the weight of the silver in one and of the chlorine in the other are in the relation of 108 to 35.5, we have the quantities necessary for the formation of chloride of silver,

and to produce such chloride of silver it is only necessary to take a silver salt, in which the silver is said to have less affinity for the other component of the salt than it has for chlorine, and a chlorine salt, in which the chlorine has less affinity for the other component of the salt than it has for silver, and to bring the salts into close enough contact (as by dissolving them separately in water and bringing the two solutions together), when chloride of silver will be formed.

If, for example, we take nitrate of silver (AgNO_3) and chloride of ammonium (NH_4Cl) in the relative quantities, 10 and 3·15, we will have weights of silver (in the nitrate of silver) and chlorine (in the chloride of ammonium) having the relation of 108 to 35·5, and as silver (Ag) has a stronger affinity for chlorine (Cl) than for nitric acid (NO_3), and chlorine (Cl) has a stronger affinity for silver (Ag) than for ammonium (NH_4), if each of the salts mentioned above be dissolved separately in water in the relative quantities mentioned, and the solution be mixed, the silver (Ag) and the chlorine (Cl) will fly together, forming chloride of silver (AgCl), and leaving over nitric acid (NO_3) and ammonium (NH_4), which will also combine, forming nitrate of ammonium (NH_4NO_3).

This double decomposition and double recombination is represented chemically by the following formula :—



Supposing now, however, that the two salts, nitrate of silver and chloride of ammonium, are not precisely in amounts by weight proportionate to 10 and 3·15, but that there is a greater proportionate amount of either one or the other. The double decomposition will go on as before, the two new products being formed, but there will remain over some of one or other of the first compounds besides. To make this clear I shall take actual figures. I shall suppose 11 grains of silver nitrate and 3·15 grains of

chloride of ammonium dissolved, the solutions being then mixed. Ten grains of the silver nitrate only will be used up, and besides silver chloride and nitrate of ammonium, there will remain over 1 grain of nitrate of silver. On the other hand, suppose 10 grains of silver nitrate taken, and 4 grains of nitrate of ammonium, there will remain over, besides the chloride of silver and nitrate of ammonium, $4 - 3.15 = .85$ grain nitrate of ammonium. In the former case there is said to be nitrate of silver "in excess," or "an excess of" nitrate of silver, in the latter there is said to be chloride of ammonium in excess as an excess of chloride of ammonium.¹

As a matter of fact it is practically impossible, even were it desirable, to so adjust the relative weights of two salts as to leave absolutely no excess; but in such a case as the above, where both the initial salts, nitrate of silver and chloride of ammonium, are soluble in water, and where one of the resulting salts, nitrate of ammonium, is also soluble, whilst the other, chloride of silver, is insoluble, the result of mixing the two solutions is to throw down as a *precipitate* the insoluble salt, which may then be *washed*, so that the last trace of the nitrate of ammonium and of whichever of the initial salts was in excess may be got rid of.

The following experiments may be performed to illustrate the formation of chloride of silver, and of the effects of excess of silver nitrate and of chloride of ammonium:—

Twelve grains of silver nitrate are dissolved in water in a test tube, which we shall call No. 1, and 3 grains of chloride of ammonium in test tube No. 2. This will give an excess of nitrate of silver.

¹ The terms "in excess," and "excess of," are used by some writers in a quite reckless and unwarrantable way. Thus, we hear it said that a certain chemical is "in excess," when it is merely intended to convey the idea that there is a large quantity of it in a certain mixture. The use of the term should be strictly confined to those cases where there is a chemical compound formed—a thing quite different from a mere mixture—and when one or other of the two or more substances going to form the compound is in larger quantity than is necessary, so that a certain proportion of it is left over after the combining.

Ten grains of silver nitrate are dissolved in test tube No. 3, and 5 grains of chloride of ammonium in test tube No. 4. These two latter quantities will give excess of chloride of ammonium.

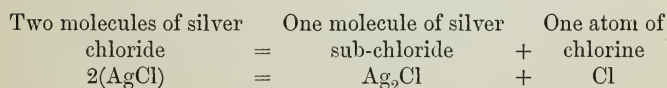
In each case the amount of water should rather less than half fill the test tube.

The contents of test tube No. 1 are now poured into No. 2, and those of No. 3 into No. 4. In both test tubes No. 2 and No. 4, there will be formed at once a thick, white precipitate. This is chloride of silver. The precipitates will settle, after which the water is poured off.

If now the two test tubes be taken into a strong light, such as sunlight, or even bright diffused light out of doors, the surface of the precipitate will darken in each case, but will darken more rapidly and to a greater extent in the case of the precipitate in No. 2 test tube where there is excess of silver nitrate, than in the case of that in No. 4 when there is excess of bromide of ammonium.

There has been a great deal of discussion as to what the dark substance actually is; but one thing that is quite certain is that its appearance is accompanied by the liberation of chlorine. Captain Abney believes it to be sub-chloride of silver. He believes that every 2 molecules of chloride of silver (AgCl) give up 1 atom of chlorine (Cl), leaving a molecule of 2 atoms of silver (Ag) and 1 of chlorine, and this hypothetical compound he calls sub-chloride of silver. Recently Carey Lea has done much to demonstrate that the substance is a compound of chloride of silver and of sub-chloride, somewhat after the manner of a lake; to this and similar compounds he has given the name of "photo-salts," "photo-chloride," "photo-bromide of silver," etc.

The supposed action is indicated chemically thus—



At any rate of this we may be certain—chlorine is given off. Now this chlorine must go somewhere, and if there

be near any substance with which it will readily combine—which will, so to speak, *mop it up* immediately that it is liberated, the action of liberation by light is much more active than if there be no such substance. Nitrate of silver is such a substance, whilst nitrate of ammonium is not, and this is supposed to be the reason why the chloride of silver darkens so much more rapidly in presence of excess of silver nitrate than in presence of excess of nitrate of ammonium.

The excess of silver nitrate has, however, a certain further action, inasmuch as it results not only in a quicker darkening, but to a certain extent, in a different colour from the beginning, the colour being bluer than it is without the nitrate of silver. Concerning this Abney states, “We have the best of reasons for believing that the blue colour is really due to a combination between the sub-chloride and the oxygen contained in the water and in the air.”

If the reader now refers to the chapters on albumenising of paper and of sensitising, he will find that the result of these two processes is to produce paper having a film of albumen containing chloride of silver with nitrate of silver in excess. But we have, besides this, the albumen to consider, not as a mere vehicle for the silver chloride, because the albumen itself becomes sensitive, or, more strictly speaking, forms a sensitive compound when treated with nitrate of silver. This is proved by the fact that it is quite possible to get prints of a kind by the use of paper albumenised without any salt at all in the albumen, and is still more conclusively proved by coating a plate of glass with pure albumen, allowing the film to dry, and dipping it for a time into the sensitising bath. We will then have a film quite sensitive to light.

The action of silver nitrate on albumen is very marked. In the first place, it coagulates the albumen, or, in other words, renders it insoluble in water either hot or cold, whereas before it was soluble in cold water. It is true that there are other means—not involving, so far as is known, a new combination—whereby albumen can be

coagulated. For example, any damp heat—as, for instance, that of steam—will have the effect. So, also, will the application of alcohol—as already mentioned in connection with “double albumenising” (see Chapter VII.)

But the action of the silver nitrate appears to be not only to coagulate the albumen, but to form an organic compound, to which the name of albumenate of silver has been given.

It is this compound which is acted upon by light in the case of a film of pure albumen which has been acted upon by nitrate of silver; but the precise action of the light upon the albumenate of silver appears to be a very complicated one. At any rate there appears to be no information obtainable as to what the image on albumenate of silver consists of. Abney, however, gives very good reasons for supposing it to be a different compound from that produced by decomposition (by the action of light) of chloride of silver, either in the presence of excess of nitrate of silver or in its absence.

We are thus enabled to arrive at the conclusion that the untuned image on albumenised paper consists of two different compounds of silver, the stability of either of which is, to say the least of it, rather doubtful.

It may be well here to state that so far the remarks made apply in some measure to the gelatino-chloro-citrate printing-out paper to be hereafter mentioned; but by no means entirely, inasmuch as the gelatine in this latter process is at no stage in contact with excess of silver nitrate, and there is probably no compound of gelatine and silver formed. On the other hand, there is present citrate of silver, which is possibly reduced by light to a different compound of silver than is chloride of silver.

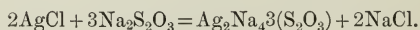
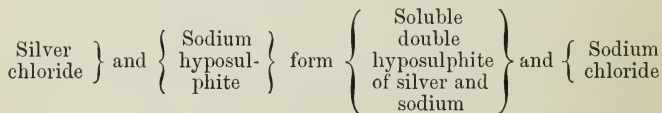
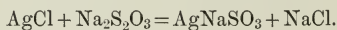
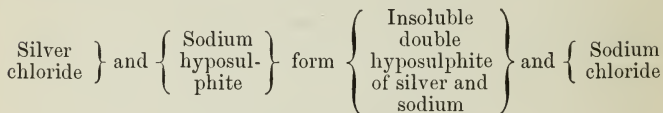
On the other hand, the images produced by the various development processes—to be hereafter described—must be looked on in quite a different light. They are composed, so far as our knowledge goes, of pure metallic silver.

Going back to the consideration of the untuned image on sensitised-albumenised paper, we have to consider the process of toning this somewhat complex image. The

subject has already been treated to a certain extent at the end of Chapter XIII., where it has been pointed out that the toning process consists in the substitution of gold in a very fine state of division for the silver compound which enters into the combination just mentioned, and where it is insisted that the greater the amount of this substitution the greater is the likelihood of permanency of image.

The image being toned, the object is to remove every trace of the sensitive compounds of silver which have not already been acted upon by light. These are the chloride of silver and the albumenate of silver.

The substance used to dissolve out these compounds—or, as it is generally put, to fix the image—is hyposulphite of soda. This substance does not act directly on the chloride or albumenate of silver, but converts them, first of all, into hyposulphite of silver, which may be soluble in hyposulphite of soda. I say may be, because, according to Abney and others, there are two hyposulphites of silver formed, one, in the presence of an excess of hyposulphite of soda, which is soluble; the other, in the presence of an excess of the silver compounds, which is insoluble. The following formulæ, representing the formation of the two compounds, are copied strictly from *The Art and Practice of Silver Printing*, by Abney and Robinson:—



The first represents the action in presence of excess of silver compound; in other words, when there is much too

little hypo used for fixing. The latter represents the action when hypo is in excess, and it is almost unnecessary here to mention that a very large excess of hypo is always desirable when prints are to be fixed, but it is well to lay stress on the desirability, already mentioned, of having the bath distinctly alkaline—to save any chance of its being acid—as an acid solution of hyposulphite of soda forms insoluble compounds of silver, even when the hypo is ever so much in excess, and therefore endangers the permanence of the prints.

To Determine the Quantity of Chloride present in a Sheet of Albumenised Paper

I said that I would describe a method of determining how much chloride has been used on a sheet of albumenised paper, in case the photographer may desire to use the knowledge as a guide to the strength of sensitising bath he will use.

The method is precisely the converse of that used to determine the strength of the sensitising bath, and is very easily practised.

A solution of nitrate of silver is made in distilled water containing $31\frac{3}{4}$ grains of the salt to each 1000 minims. A sheet of the paper to be tested is cut up into little bits, is placed in a glass measure, and about half a pint of distilled water is poured over it. The paper is allowed to soak for, say, an hour with frequent stirring, when enough chromate of potash is added to make the solution of albumen and chloride slightly yellow. The silver nitrate solution is now poured into a burette holding 1000 minims, and is slowly run into the mixture of paper, water, etc., whilst the latter is stirred. As the silver nitrate solution touches the water, it will produce a red stain which, however, disappears as the stirring goes on. After a time, however, it will disappear more slowly. The addition is now very cautiously made, and just when the red colour becomes quite constant—no amount of further stirring sufficing to drive it off—the burette is read. Every

100 minims means that the sheet of paper was albumenised with albumen containing 1 grain of chloride of ammonium, or the equivalent of some other chloride. Thus, if 672 minims be read, the sheet of paper had 6·72 grains of chloride of ammonium in it.

CHAPTER XV

SILVER PRINTING

Gelatino-Bromide of Silver for Printing—Direct Enlarging

PRINTING on gelatino-bromide of silver has of late years become very popular. The process consists of impressing, with a very short exposure to light, an image on a paper-supported film of gelatino-bromide emulsion, and afterwards developing, generally with weak ferrous oxalate.

There are various advantages in the process. The colour in the first place is an engraving black. This is not admired by all; but by those who have artistic knowledge it appears to be generally preferred to the brighter colours got by the process commonly entitled "silver printing,"—that is to say, printing on albumenised paper. To the writer it appears that, although the colour (and he may add the surface) is not very well suited to very small work, it is suited to all other, and particularly to very large work.

The precise degree of permanency offered by bromide prints is a matter at present under discussion, and therefore I say nothing of the matter further than to state that prints by this process are almost certainly of a much more stable nature than those on albumenised paper, and that it is quite likely they are "permanent" in the sense that they will, if properly prepared and fairly treated, last as long as the paper that supports them.

The great advantage of the process undoubtedly is, however, the shortness of exposure needed. So brief is

this that, in the case of contact printing, it is not usually advisable to print by daylight at all, as the exposure would be so short as to be quite beyond control. The exposure at two or three feet from a gas-burner will vary from a second or two to a minute, according to the density of the negative and the rapidity of the paper, the paper of different makers varying a good deal in sensitiveness.

The great sensitiveness of gelatino-bromide paper as compared with other kinds of paper for positive printing renders it particularly well suited to direct enlarging, which will be briefly described. Contact printing calling, however, first for attention.

Contact Printing with Gelatino-Bromide Paper

The printing may be done in the usual way in the ordinary printing-frames, the paper being, of course, manipulated only in the dark room, and exposure being made at, say, three feet from an ordinary burner. As there is no visible image, it is necessary to determine the exposure by one or two trials. After this printing can go on for any length of time, as the light from an ordinary gas-burner varies so little that there need be no fear of irregularity in the results if the same exposure be given over and over again.

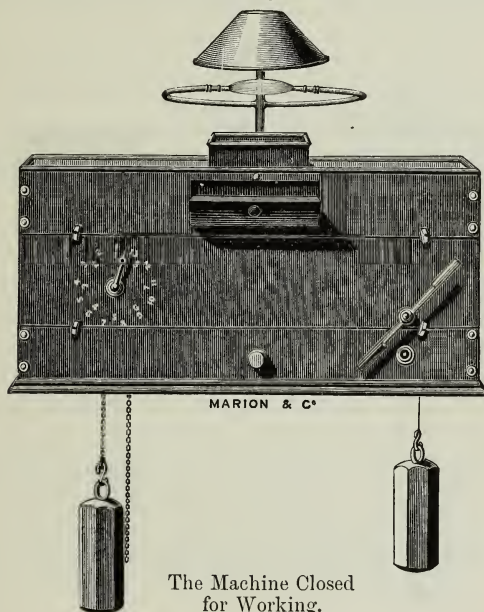
A very ingenious machine has been invented by Urie of Glasgow for printing a number of impressions from a single negative. The paper in this case is used in a continuous band, which is brought under the negative, being moved on the length of a print after each exposure. The light is supplied by a gas-burner over the negative, a flat dish of water intervening to prevent any heating of the plate. The light is automatically lowered for an instant as the band travels.

The exposure is determined by trial and error at first ; the machine is then regulated to give the same exposure over and over again, and may be left to its own sweet will. I here illustrate the appliance.

Development

It will be found that each maker of paper issues a formula for development, and it is well—as in the case of plates—to adhere to this formula, although it appears to be by no means necessary.

What is necessary is that the developer be not very strong, and that it be distinctly acid. In fact, the writer

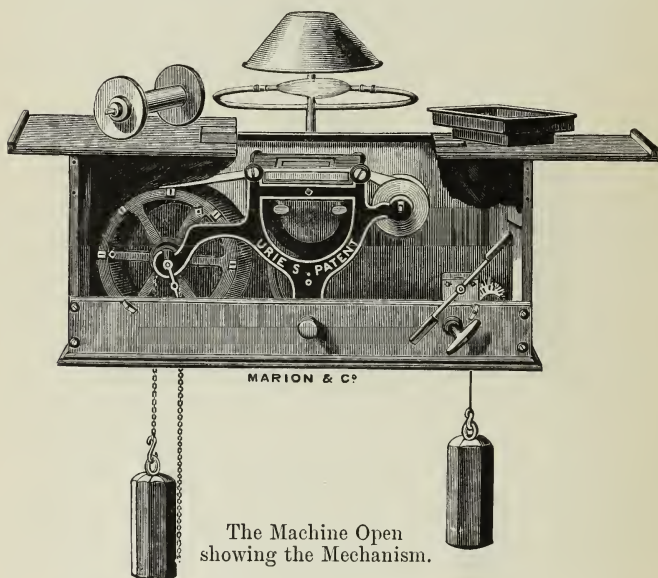


has found an improvement in results to arise from the use of what might at first sight appear to be an enormous quantity of acid. Thus he has found that 3 per cent of citric acid or 1 per cent of sulphuric acid added to the mixed developer had no great retarding effect on the development, whilst it ensured lights of a pearly whiteness. This is, however, an amount which it is perhaps rash to use. About half of this quantity may, however, be made use of without any hesitation.

The following developer may be taken as one which will give good results with almost any brand of paper:—

Saturated solution of ferrous sulphate .	1 ounce
Saturated solution of oxalate of potash .	4 ounces
Water	5 „
Citric acid	50 grains

The paper (exposed) is first soaked in water, great care



being taken to remove any air bubbles which may adhere to the surface. It is then placed (film side upwards) on the bottom of a white dish, and the developer is poured over it. The image will quickly appear and must be closely watched, for it must be borne in mind that there is no reduction of depth in the fixing bath. The print deep enough, is at once removed to a 2 per cent mixture of sulphuric acid and water. It may remain here till others are developed if there are a number.

When the negative is thin and full of detail—a particularly suitable negative for most brands of paper—the exposure must be short and the development must be comparatively protracted, occupying perhaps five to eight minutes. If, on the other hand, the negative be of full density, the exposure is prolonged to such an extent that, with a development such as that given to the print from the thin negative, the whole image would be enveloped in fog. In fact, the exposure must be increased more than in proportion to the density of the negative. The prints from the dense negative require but a short development. Very often not more than half a minute, and it is necessary to watch very closely to prevent the process from going too far, the result in such a case being a clogging of the shadows, and also, very likely, a degradation of the whites.

If it be desired to get a good print from a *very* thin negative some restrainer may be added to the developer, but normally this is not required.

It will be perceived that by varying the exposure and adjusting the developer to suit it, there is a great power of getting prints, having similar characteristics, from negatives varying very much in the matter of density; but it must be understood—as indeed may be understood of any printing process—that from an under-exposed negative no good result can be expected.

The prints developed should be passed through two or three baths of weak sulphuric acid to remove the last trace of iron from the paper.

Fixing the Prints

After the developed prints have gone through the acid baths, they are but slightly sensitive to light, and may be further manipulated with almost as much freedom as prints on albumenised paper,—that is to say, they may be freely exposed to gaslight, or even to very dull daylight.

The acid must be got rid of before fixing, otherwise the permanence of the print will be endangered just as already

explained in the case of a print on albumenised paper. The washing necessary to remove the last trace of acid is very great; and it is therefore advisable, after washing for ten minutes or a quarter of an hour in running or frequently changed water, so as to get rid of the greater part of the acid, to place the prints for a few minutes in a weak solution of washing soda. They are then placed in an ordinary fixing bath, such as is used for negatives, but it must be freshly mixed, and should be used only once. It may be retained afterwards for fixing negatives. The prints must be kept moving in the fixing bath. It is not very difficult to see when fixing is complete. Only a few minutes are required, but it is well to have the prints in the fixing bath from ten minutes to quarter of an hour. When fixed, they are washed just as carefully as are prints on albumenised paper.

Pyro-Developer for Bromide Paper

Very good results can be got on bromide paper by the use of almost any pyrogallie acid developer which is weak, contains a considerable quantity of restrainer, and a large quantity of sulphite of soda. The colour got—although it can only be called a black, like that got by the iron developer—is slightly different, and is preferred by some.

Ammonia may be used as the alkali, but as a rule better results will be got by the use of carbonate of potash or of soda. The following carbonate of potash developer will be found to give good results:—

Stock Solution

A {	Pyro	1 ounce
	Sulphite of soda	4 ounces
	Citric acid	$\frac{1}{4}$ ounce
	Bromide of ammonium	$\frac{1}{4}$ „
	Water	up to 10 ounces

Dissolve, with heat, the sulphite of soda in 8 ounces of water, add the citric acid and the bromide of ammonium,

pour the liquid over the pyro, and make the quantity up to 10 ounces.

B {	Carbonate of potash	.	.	.	1 ounce
	Sulphite of soda	.	.	.	1 „
	Water	.	.	.	up to 10 ounces

To develop, take for each ounce of developer required 15 minims of A and 40 of B, and make up with water. The development will be slower than with iron.

Warm Tones with Gelatino-Bromide Paper

So far as I am aware, A. Cowan was the first to show that there is, at any rate in the case of some samples of bromide paper, a very appreciable range in the tone obtainable, an approach to a sepia tint being got by exposing many times as long as is necessary to obtain a black tone, and by using a very much restrained developer. Those who wish to experiment in this direction may try the result of giving an exposure ten to thirty times longer than is necessary for a black tone, and of adding 6 to 8 grains of bromide of ammonium to each ounce of the developer.

Vignetting Gelatino-Bromide Prints

Gelatino-bromide is particularly well suited to the production of vignettes. The vignetting is done in precisely the same way as if the paper to be used were sensitised-albumenised paper, a piece of tissue paper being however *always* used in front of the vignetter.

Direct Enlargement on Gelatino-Bromide Paper

As has already been mentioned, gelatino-bromide paper is particularly well adapted to direct enlargement. In fact, before its invention, direct enlargement was a thing scarcely practised but by large firms, who could afford to erect the ponderous arrangement known as a direct solar-enlarging camera, or by those who cared to go in for the

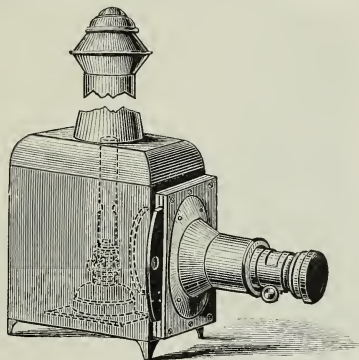
somewhat difficult process of collodion transfers. Indeed, the practice of direct enlargement was a thing beyond the scope of amateur photographers, and even of the bulk of professional photographers; but the advent of gelatino-bromide has changed all this, and to enlarge is now almost as easy as to make a contact print.

I ought to explain that *direct* enlargement means enlargement without the necessity of first producing an enlarged negative as in many enlarging processes.

Most readers of course understand the principle of direct enlargement; but those who do not will readily conceive it by considering the action of the optical or "magic" lantern. In this a small transparency, placed behind an objective, produces a greatly enlarged image on a screen at some distance. If a sensitive film took the place of the screen, there would of course be produced on this film an image which, in the case of the ordinary *positive* lantern slide, would be a *negative*. With a *negative* used as the slide, however, it would be a positive, and the fact is that enlarging lanterns are optically the same in principle as "magic" lanterns.

An enlarging lantern is shown here. This is used in a room, which is illuminated only with red or yellow light, as in the ordinary dark room. The image is received for focussing on a piece of ordinary white paper fixed to a board, the distance between which and the lantern can be adjusted. The farther the paper is from the lantern the larger will be the image. The image having been focussed quite sharp, the cap is placed on the lens, the plain paper is removed from the board—without disturbing the position of the latter—and the gelatino-bromide paper is fixed with drawing pins in its place. The cap is then removed and the exposure begins. This may vary from a minute to an hour. It is greater the greater the amount of enlargement. It varies as the square of the number of times that it is required to enlarge. For example, it is required to make two enlargements from the same negative: one twice as large, the other three times as large as the negative. These measurements are *linear* measurements, not square. Such

enlargement is commonly expressed by saying that the one is a "two-diameter" enlargement, the other a "three diameter." The exposures required for these two enlargements would vary as two squared (2^2) to three squared (3^2),—that is to say, as 4 to 9. The larger enlargement would require fully twice the exposure of the other. Of course the exposure required varies also with the density of the negative, with the lens used, with the intensity of the light, and with the sensitiveness of the paper. It is well, if there is any doubt as to the time needed, to expose a small piece of paper first on a part of the subject—such as the face—that will serve to indicate satisfactorily if the exposure is



right or not, and if not right, will serve to give an idea of how much correction it needs.

The exposure finished, development, etc., proceed precisely as in the case of contact printing.

The lantern is certainly the most convenient appliance for the production of direct enlargements, and it is, moreover, capable of producing the very best results, but it has one drawback. Except for enlarging *from* small negatives, it is a very bulky and expensive piece of apparatus. Indeed, I am not aware that dealers keep lanterns for enlarging from negatives larger than half-plate. If they are needed to enlarge from larger negatives, they have to be specially made. The size that it is necessary to enlarge *to* is not of consequence.

The best way in which to enlarge from any negative larger than half-plate, and a way, at least as good as the lantern method for small negatives, is that by daylight. The method is really precisely the same, the only difference being that the negative, in place of being illuminated by artificial light, concentrated by a condenser, is illuminated by diffused daylight.

A darkened room is necessary, and also a camera of some sort that will hold the negative, to be enlarged from, in such a position that it is illuminated by daylight from outside, and that will shut out all daylight except such as passes through the negative, and is needed to form the

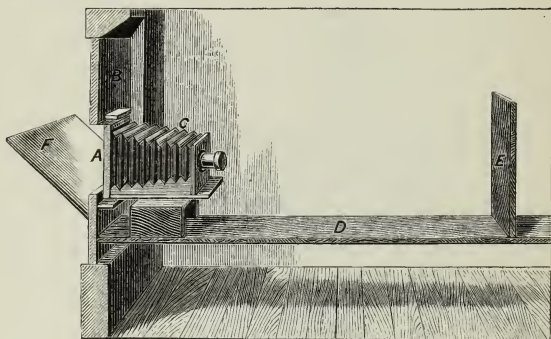


image. Special cameras are made for the purpose of daylight enlarging and are very convenient. It is quite possible, however, to work with an ordinary camera. A dark slide, of the American pattern, in which the shutters draw completely out, is needed, or a frame to hold the negative may be made, but otherwise any camera just as used in the field is fitted for enlarging work.

The above cut will show the arrangement. C is an ordinary landscape camera, placed with its dark slide end against an opening cut in a shutter B. At A is the American dark slide with both shutters withdrawn, or the special frame holding the negative to be enlarged from; E is a board for holding the focussing paper, and afterwards the sensitive film. It is adjustable along the board D.

F is a screen covered with white paper, and fixed at an angle of about 45° , with a horizontal or perpendicular line. Its function is to show an even diffused light behind the negative. When the window looks to the north, it is possible, by sloping the board D, so that the camera has the sky behind it, to dispense with the board F.

In working the arrangement, a rough adjustment for size of enlargement is made with the board E, and the final sharp focussing is done by racking the front of the camera.

The exposure will average perhaps a third or a fourth of that needed with the lantern. The same rule as to the relation of number of times enlarged and exposure holds good in using daylight as with the lantern.

A word as to the lenses best suited for enlarging. It is possible to enlarge with any lens; but a single landscape lens is not suitable for enlarging from negatives of architectural subjects, for the same reason that it is not suitable for photographing them. A lens of the rapid rectilinear or rapid symmetrical type is probably the most suitable.

A thing to be avoided is the use of a lens of too short focus. The focal length of the lens used for enlarging should be at least half as great again as the length of the plate enlarged from. It is particularly necessary to observe this when a portrait lens is used.

Vignetting direct Enlargements

When it is wished to vignette a direct enlargement, the vignetting is done by shading the edges during the exposure with a shade having in the middle of it an opening, of the shape wished for the vignette, but much smaller. This vignetter is then fixed between the lens and the sensitive paper, but nearer the former. The right position must be determined by trial. The larger the aperture of the lens, and the nearer the shade to the lens, the greater the softness of gradation. If, therefore, the aperture of the lens be comparatively small, it is necessary

to have a comparatively small opening in the vignetter, and to fix the latter nearer to the lens than if there be a large aperture. It is fortunately easy to judge of the effect on the screen before the sensitive paper is pinned in position.

CHAPTER XVI

SILVER PRINTING—*continued*

“Rapid” Printing Process

THE process which bears the above name may be said to lie about midway between the gelatino-bromide process, already described, and the gelatino-citro-chloride process to be described in the next chapter.

In the first-mentioned of these the paper is coated with a gelatino-bromide emulsion ; the exposure required is very short, and the range of tone is very small, the prints being of an engraving black, or of a colour approaching thereto, and being, therefore, not amenable to toning.

In the second process the paper is coated with gelatino-citro-chloride emulsion, prints out like sensitised-albumenised paper, and is toned in a similar manner.

The rapid paper is coated with a chloride of silver emulsion, or a bromo-chloride of silver emulsion,—that is to say, an emulsion consisting of both bromide and chloride of silver suspended in gelatine. The emulsion is slow, and is always, or at any rate sometimes, prepared in the presence of a large quantity of free acid. It has been said by manufacturers of the paper that it is not of much consequence (the presence of free acid and other conditions being observed) whether the emulsion be of bromide of silver, or of chloride of silver, or of a mixture of both.

Advantage is taken, in working the process, of the fact that, in the case of paper coated with an emulsion, such as that indicated, it is possible to get, by a very

prolonged exposure—one several hundred times as long as that necessary to produce an image in all its detail—and the use of a weak and very heavily restrained developer, an image of a red colour, which may afterwards be toned with gold. The advantage of the process may be said to be that, by its means it is possible to produce, by exposures to artificial light, prints having all the range of tone that is shown in prints on albumenised paper.

It is possible to get, in fact, a very wide range of really beautiful tones. There has, however, been found by some a difficulty in getting a number of prints of uniform tone. It is probable, however, that this difficulty would be overcome were the process as long practised and as well understood as the process of printing on albumenised paper, or it might, indeed, be urged that “variety is charming.”

Exposure of the Paper

The paper is ordinarily exposed by contact, but the writer has seen some very fine enlargements done on it, the exposure being by daylight, with a lens of the portrait form, and being pretty long even then. The exposure to artificial light would be so long as to be entirely out of the question.¹

The exposure needed by contact is a second or two to ordinary diffused daylight, at a foot from an ordinary fish-tail gas-burner from three minutes, for a thin negative, upwards, perhaps about eight minutes being needed for an average negative. By using a duplex paraffin-lamp as source of light, with a bright tin reflector behind it, and by placing the frame, say 8 inches from the light, the exposure may be reduced to $\frac{1}{15}$ or $\frac{1}{20}$ of those required with an ordinary fish-tail burner.

No image is visible with a negative showing average contrast. With one of very strongly marked contrast the shadows will be just faintly visible. It may be useful, as a criterion of the exposure necessary, to say that in the

¹ See Chapter XV. for detailed descriptions of enlarging by daylight and artificial light.

case of a quality of negative, by no means uncommon in modern dry-plate work, especially in the case of landscapes, one having bold contrasts, but a considerable veil even in the deepest shadows, a scratch made in the film—of course in practice quite at the edge—should just show faintly after exposure.

The paper, being comparatively slow for development paper, may be manipulated in quite a bright red, orange, or yellow light, or even in a moderate amount of gas or lamp light. Thus, if it be not exposed for any very long time to the light, it may be manipulated at 10 to 15 feet from an ordinary fish-tail burner burning at its full strength.

Developing the Prints

The following may be taken as a typical developer for working "rapid" paper, although it is, of course, only fair to use, with any brand of paper, the formula recommended by the maker. The following solutions are made up:—

A	{ Oxalate of potash	4 ounces
	{ Bromide of ammonium	100 grains
	{ Warm water	1 pint
B	{ Sulphate of iron	1 ounce
	{ Water	20 ounces

Both solutions are made perceptibly acid to test paper, and enough is taken of each in equal quantities to fill the developing dish to a depth of at least half an inch. This dish, by the way, must be at least an inch each way larger than the prints to be developed.

The solutions are mixed just before development is to begin, by pouring the iron into the oxalate of potash solution, not the potash into the iron.

The prints are placed dry in the developer, not more than two or three at a time, and are kept in continual motion till development is complete. The image must be watched very closely, as it loses nothing of its depth in the after processes, and must, therefore, on no account be allowed to develop to a deeper tint than is finally needed.

Indeed, the development is liable to continue for a little time, if the prints be placed, after development, simply in cold water. For this reason the writer recommends that a solution of bromide of ammonium—10 grains to the ounce or so—be prepared, and that the prints be passed directly into this after coming from the developer. This solution will at once stop all action. Whether the prints go first into a dish of clean water or of a solution of bromide of ammonium, they must be passed within a few seconds into a second bath containing clean water, and then into a third, it being essential to prevent a tendency towards yellowness in the whites to wash the developer out of the paper very rapidly. The developer may be used for as many prints as can be developed within about half an hour, but must not be used for a longer time than that after the first print has gone into it.

The colour of the prints, as they come from the developer, if it be wished to gain any colour other than an engraving black, should be something approaching a dusky or brick-red.

The prints, after they have been washed, by being passed rapidly through three or four waters, and being left for a few minutes in the last, are passed into a saturated solution of alum, where they remain for quarter of an hour. They are then again washed by keeping them rapidly moving in changes of water for quarter of an hour, when they are ready for toning.

I should mention that various other developers, besides that given, may be used with the paper, for example, ferrous citrate, or a simple aqueous solution of hydrokinone.

Toning the Prints

The following toning formula is that recommended by one maker of the rapid paper :—

Acetate of soda	60 grains
Chloride of lime (fresh) . .	4 „
Chloride of gold	2 „
Water	1 pint

The water is poured hot into the acetate of soda and chloride of lime, and the gold is added when the solution has become cold.

The prints, by the time that they have reached the toning stage, may be manipulated in dull daylight—in fact, just as prints on albumenised paper.

The toning proceeds rapidly as judged by reflected light; but if the prints be removed from the toning bath when they have acquired the desired colour on the surface, they will “go back” to such an extent in the fixing bath as to appear woefully undertoned. If they be toned to a deep purple by reflected light, they will give a fine brown after fixing. If any colour deeper than this is required, it is best to judge by looking through the prints.

Warnerke recommends a bath for toning and fixing at one operation. Such a bath may be made by adding 1 grain of chloride of gold to each 4 ounces of a solution consisting of 5 ounces of hypo to the pint of water. Much trouble is saved by working in this way, and the method has the advantage, that by its use it is possible to judge more easily of the colour, because we can judge by reflected light, the prints not changing appreciably after they come from the bath.

Fixing the Prints

This operation is performed exactly as directed for prints on albumenised paper. If the prints have been toned in the bath just mentioned, it is by no means absolutely necessary that a second fixing bath be used; but its use probably increases the chance of permanency in the prints.

After fixing, the prints are washed in the same way as are prints on albumenised paper. The various methods adapted to finishing and mounting of prints on rapid paper will be treated of in a future chapter on “Mounting, Enamelling, and Finishing Prints.”

The greatest care must be taken to prevent any trace of hypo from getting into the developing solution, or of

developing solution from getting into the toning bath, otherwise failure is certain to ensue.

If vignettes be attempted, they should always be developed in fresh solution, to ensure purity in the white margins.

CHAPTER XVII

SILVER PRINTING—*continued*

Gelatino-Chloride Papers for Printing Out

By reference to our chapter "On the Chemistry of Silver Printing,"¹ it will be seen that the presence of nitrate of silver in excess is necessary to get a bold print in chloride of silver when albumen is the vehicle. Chloride of silver, without the presence of nitrate, giving but a poor image.

The same remark applies when gelatine is the vehicle, except inasmuch as there are certain organic salts of silver which may be substituted for silver nitrate.

There are objections to the use of free silver nitrate in connection with gelatine, because a compound of silver and gelatine is formed, which it appears to be impossible entirely to eliminate, and which, therefore, causes eventually a darkening of the whites of any prints which may be formed on a film of gelatine in presence of free silver nitrate. The same does not apply to such organic salts of silver as the citrate and acetate, whilst these have the effect, when used in conjunction with chloride of silver suspended in gelatine, of producing brilliant prints.

The salts are produced in suspension in a solution of gelatine by what is known as the emulsion method. A few words on the preparation of the paper will be given at the end of the chapter ; but in the meantime I shall go on

¹ Chapter XIV. p. 102.

the assumption that the photographer has either made or purchased his paper, and wishes to print with it.

The paper is sold by several firms under such names as "Aristotype," "Chloride of Silver," "Emulsion Paper." It keeps well, considerably better than the best preserved papers that the writer has had experience of, and is ready for use at any time. It gives prints of exceeding brilliancy, and is especially useful for getting impressions from very thin negatives. It will give a brilliant print from a negative from which only very poor results can be got on albumenised paper. From this it might be inferred that, of necessity, it would give a hard print from a brilliant negative, and it is true that from a negative of the type which is *all but too hard* for printing on albumenised paper, but yet gives good results on such, only hard prints can be got on gelatino-chloride paper; but with the ordinary run of good plucky negatives suitable for printing on albumenised paper, good results are to be got also on gelatino-chloride paper. The character of the prints on the two papers is entirely different, in a way that it is not easy to explain, but they are both good.

The only drawback to the paper is its price, which is at present much greater than that of even the most expensive sensitised-albumenised paper. This ought not to weigh much with the photographer, who should never sacrifice excellence to cheapness, and I have no hesitation in saying that the results on gelatino-chloride paper are better than those on albumenised paper, at any rate when it is necessary, as it sometimes is, to make the best of a somewhat thin negative.

It seems probable that the prints on gelatino-chloride paper are more permanent than those on albumenised paper, and this for two reasons: (1) Neither the gelatine nor the paper has during any part of the process been in contact with free silver nitrate, which is one undoubted cause of the fading of prints on albumenised paper; and (2) more gold is taken up in the toning process. Indeed, the writer has reason to believe, as he will hereafter explain, that in this process it is possible entirely to

replace the silver compound with gold to form the image.

Manipulation of Gelatino-Chloride Paper

The paper is printed in the usual way. The time taken is shorter than that required for albumenised paper, perhaps one-half as short or thereby. It is, as in the case of albumenised paper, necessary to allow for future reduction by over-printing in the first place. The prints when they come from the frame are set on one side and will keep, if wished, for months before they are toned.

The following toning bath is a modification of that issued by a certain maker of the paper. It has been selected by the writer from a number tried by Mr. Lionel Clark, who some time ago showed the results of various developers on the gelatino-chloride paper :—

Chloride of gold	1 grain
Hyposulphite of soda	1 „
Sulphocyanide of ammonium	20 grains
Water	3 ounces

The sulphocyanide of ammonium and the hyposulphite of soda are dissolved in 2 ounces of water, the chloride of gold in 1 ounce, and the gold solution is poured with stirring into the other.

Somewhat more than 2 grains of chloride of gold is, in my experience, required for each 22×17 inch sheet of the paper ; but as it is possible to add gold as the process proceeds if it be found necessary,—as indicated by a stoppage of the action,—it is best to start with a quantity not larger than 2 grains of gold chloride to each sheet—6 ounces of toning solution that is. It is scarcely possible to work with less than this, as any smaller quantity of solution is too little to permit of the manipulation of the prints in it. The sulphocyanide of ammonium has a tendency to dissolve the gelatine of the film if it be in very strong solution. It is, for this reason, advisable to be careful that the quantity mentioned be not exceeded—

in fact, in hot weather, it is advisable to reduce it a little, say, to 15 grains to the ounce.

The prints are washed for a few minutes only—say three minutes—before toning, and here it may be well to give a word of warning. On account of the action of the sulphocyanide just mentioned, the gelatine becomes very soft and soluble, and care must be taken never to hold the paper by one place, between the finger and thumb, for any length of time, or parts of the film will be dissolved away. The writer has seen an operator holding a small print for a few seconds on the points of his fingers and thumb when, quite suddenly, the film dissolved away over the spot touched at the back of the paper. Of course it will be thoroughly understood that the remarks just made apply only to the paper in the wet state. For the same reason that the paper must not, whilst wet, be handled carelessly with warm fingers, so also care must be taken never to warm any of the solution through which the prints pass. Thus the toning solution must on no account be warmed if the process be progressing sluggishly, as it may be when albumenised paper is being worked. Indeed, when the weather is very hot, it may be necessary to cool the solutions artificially with ice. They should never rise above a temperature of 65° Fahr.,—that is to say, any solutions used before the alum solution, which latter would probably do no harm were its temperature as high as 75° Fahr.

As the prints go into the toning solution a sudden (and generally a very disagreeable) change will probably take place. They will become of an exceedingly sickly yellow colour, and will possibly appear very uneven. This, however, is not of consequence, as the inequality of colour disappears as the toning proceeds.

It is a little difficult to judge of colour at first, the difficulty being somewhat the same as that mentioned in connection with the “rapid” printing process in the last chapter. The case is not exactly the same, however. If we judge of the colour of our print by reflected light, by looking *at* it, it is sure to be undertoned eventually. If,

on the other hand, we judge by looking *through* it, it will probably appear somewhat overtoned when complete,—that is to say, toned to a deeper colour than we saw when looking *through* it. By bearing in mind, however, that the eventual tone will be somewhere between that seen by looking *at* the print and that seen by looking *through* it, but somewhat nearer the latter, it is easy with a little practice to get good and uniform results. Again, as in the case of the “rapid” purple, if the prints be toned just till they show a dark purple when looked *at*, they will eventually give a fine brown.

One advantage the process has, it appears to be impossible to overtone in the sense in which it is possible to overtone a print on albumenised paper. If a print on this latter paper be kept in the toning bath for too long a time the colour changes to a slaty tint, and all the depth and brilliancy of the print is gone. The chloride paper, on the other hand, appears never to go beyond an engraving black. The writer has left prints, already toned to a deep black, in a still active toning bath for a full half hour, and they have suffered no degradation of tone—have merely still remained black; and this fact makes him believe that it is possible with gelatino-chloride paper to replace the *whole* of the silver image with gold, and therefore to get prints of great permanency.

The prints, when they have reached the right colour, are passed directly—without intermediate washing—into a fixing bath, which may be made up of—

Hyposulphite of soda	.	.	.	2½ ounces
Water	.	.	.	1 pint

They remain here for ten minutes or so, with frequent movement, and must then be carefully washed. This is about the most troublesome part of the business if an automatic washer of some kind be not used, because, as has already been stated, prints cannot be thoroughly washed unless they be kept continually moving; and it is advisable to manipulate the gelatino-chloride prints as little as possible till they have been in the alum bath. Still they can be

changed from dish to dish by hand as described for prints on albumenised paper, if due care be taken. If they be kept constantly moving, half an hour of washing is sufficient. After this washing the prints go into a saturated solution of alum for quarter of an hour. This greatly hardens the film, which may afterwards be manipulated with great freedom. The prints are now once more washed to rid them of the last trace of alum. A washing of quarter of an hour, with continual change of water and motion of prints, should be sufficient for this.

The prints may be dried in the same way as prints on albumenised paper, but they must never be left for any time pressed between blotting-paper. So dried, they look very well if mounted and rolled; but many prefer the exceedingly brilliant effect produced by mounting the prints wet on glass which has been treated with French chalk, allowing them to dry thereon, and then stripping them.

The Manufacture of Gelatino-Chloride Emulsion for Printing out

The description of this process must be very brief, and is indeed inserted only for the sake of completeness, as it is probable that few will attempt to make their own gelatino-chloride paper.

The most complete work on the subject that the writer knows consists of a series of articles by W. M. Ashman and R. Offord, running through the *Photographic News* for the years 1885 and 1886. The following information is abstracted from these articles. The instructions given are on the assumption that the reader is familiar with the ordinary manipulation of emulsion work. It would be impossible to afford space to describe these.

Two separate emulsions are made in the following manner :—

1. Chloride of Silver Emulsion

For this are taken—

A	{	Ammonium chloride	53	grains
		Gelatine	420	„
		Water	20	ounces
B	{	Silver nitrate	150	grains
		Water	$\frac{1}{2}$	ounce

2. Citrate of Silver Emulsion

A	{	Citrate of sodium	30	grains
		Gelatine	100	„
		Water	$3\frac{1}{2}$	ounces
B	{	Nitrate of silver	45	grains
		Citric acid	80	„
		Water	$\frac{1}{2}$	ounce

The gelatine in A of the chloride emulsion should be about one-third soft—say Nelson's No. 1—and two-thirds hard—say Heindrich's.

The gelatine in the citrate emulsion A is to be all hard. The solution A for the citrate emulsion is to be prepared as follows :—

The gelatine is dissolved by soaking in 3 ounces of the water and warming. The citrate of soda is then dissolved in the half ounce of water remaining, the solution is warmed, and is gradually added with stirring to the gelatine solution.

The chloride emulsion is completed in the following manner :—

The gelatine of solution A is melted by soaking and warming. The ammonium chloride is added, and whenever it is dissolved, the solution B, slightly warmed, is added drop by drop with continual stirring. The emulsion is then put on one side till it is quite stiff, when it is ready to be washed by passing it through mosquito netting or very coarse canvas, and allowing it to remain for five minutes in each of three or four changes of water. It now requires only to be drained, when it is ready for use.

The citrate emulsion is mixed in precisely the same way, care being taken not to raise the temperature of

the solution higher than is necessary to secure thorough emulsification. It is washed just as described for the chloride emulsion, and then 15 grains of citric acid are added.

The two emulsions are now remelted and mixed, and are ready to be used for coating paper.

Any very pure paper, which is perfectly white and is well sized, may be coated with gelatino-citro-chloride emulsion; but it is evident that commercial makers coat their paper with an insoluble, or semi-insoluble, substratum of gelatine, containing a white pigment. Probably the "single" transfer paper used in carbon printing would suit the purpose.

The paper may be coated in any of the ways afterwards described for coating paper with carbon tissue, or may be coated as described by Ashman and Offord in their articles in the *Photographic News* already referred to.

CHAPTER XVIII

SILVER PRINTING—*continued*

The Collodio-Chloride Process of Simpson

THE collodio-chloride process was invented by G. Wharton Simpson in 1864. It had an immediate success; was, for some time at least, quite extensively used, and was proclaimed on all sides to be an advance in photographic printing.

The process was, I think, deservedly thought well of, and yet it has quite or all but quite fallen out of use, probably on account of the many competing processes that there now are, and perhaps because photographers of the present day are, as a rule, so much less accustomed to the use of collodion than were those of a quarter of a century ago, that they do not take to it kindly.

The process consists in producing an emulsion of chloride of silver, in the presence of free silver nitrate, and sometimes of an organic acid, in collodion. The collodion can be spread on nearly any surface that it is desired to print on, and a visible image that only needs to be toned and fixed is got in the printing-frames. The process was originally intended for application to paper, but, as has been said, it may be applied to various other surfaces, and amongst these to that of opal glass, with the result that very beautiful prints are got. Again it may be applied to plain glass, when excellent transparencies can be got.

I do not know whether either the paper or the prepared collodion is now an article of commerce, but they were

both procurable on the Continent a few years ago ; and in Britain, at least one distinguished professional photographer continued to use the process for his regular work, producing results of the highest excellence.

It is likely that prints on collodio-chloride are much more permanent than these on albumenised paper.

Those who wish to try the process may proceed as follows :—

Any collodion that is of fairly good body, and that gives a perfectly transparent film on glass, may be used. Of course it is understood that it is not to be iodised.

The following are made up :—

A

Nitrate of silver	1 ounce
Water	1 „

B

Chloride of calcium	160 grains
Alcohol	10 ounces

C

Citric acid	160 grains
Alcohol	10 ounces

A little heat may be necessary to aid the solution of the silver nitrate.

To a pint of collodion we take 3 drams of “A” and dilute it with $2\frac{1}{2}$ ounces of alcohol ; this is then added slowly with shaking, and afterwards, still with shaking, and preferably in the dark room, $2\frac{1}{2}$ ounces of each of “B” and “C” are added. The emulsion is now ready to be used for coating any surface that is selected. It will keep good for some months. The alcohol used should be that sold as “absolute alcohol.”

If glass, either transparent or opal, is to be coated, it is done in the usual way, and the film has merely to be allowed to dry when it is ready for exposure. It is generally advisable to edge the glass either with albumen

and water or with ordinary negative varnish, as the film is very liable to strip off in drying if no precaution be taken.

Any of the many kinds of paper may be used. The best, however—or, at least, one of the best—is a fine quality of paper sized with arrowroot, and with a highly-rolled surface. To coat a piece of paper, either a sheet of glass or a flat board, a little larger than the paper, is used. The paper is placed on this, with the side to be coated upwards, the edges of the paper are very slightly turned up, and the collodion is poured on much as in the case of coating a glass plate.

The prints are printed, washed, toned, fixed, and again washed, like prints on albumenised paper, but a very weak fixing bath only is necessary.

The greatest difficulty that will be found in actually working the process is the tendency that there is to uneven toning on account of unevenness of the collodion film. This can only be overcome by practice and patience.

CHAPTER XIX

SILVER PRINTING—*continued*

Defects in Silver Prints and their Remedies

THE worker at the various processes of silver printing is certain before long to come across various annoyances in the way of defects in one or other or all of the processes of silver printing that have been described. Sometimes the defects are more or less difficult to trace to their origin, and consequently to stop them is difficult; but, as a rule, it is not necessary to do much more than mention the cause of the defect, when the remedy will readily be found. In the next few pages there are given all the defects with which the writer is acquainted, and their remedies when they are remediable.

Each of the four principal silver printing processes that have been treated of—printing on albumenised paper, gelatino-bromide printing, “rapid printing” by development, and printing on gelatino-chloro-citrate paper—is touched on.

The Prints Refuse to Tone

In the case of *albumenised paper prints* the cause may be any one of several. A good deal has been said on toning in previous chapters, and amongst other things it has been mentioned that preserved paper is much more difficult to tone than that prepared on a neutral bath, and that, moreover, double albumenised paper takes longer to tone than single. In a weak bath it may be found *impossible* to tone

some brands of double albumenised-sensitised paper. The remedy is to strengthen the bath with chloride of gold. Another cause may be acidity of the toning bath, which should always be kept on the side of alkalinity. Again an extreme degree of cold may prevent the action of the toning bath completely. In this case it may be warmed, but should never be raised to a higher temperature than 70° Fahr.

If paper prepared at home refuses to tone, the sensitising bath should be looked to. If this be acid or be much loaded with organic matter, there is certain to be difficulty in getting a good tone.

If a toning solution used time after time, such as the acetate, refuse to tone, it may be suspected at once that the gold has been thrown down. The bottle should be examined for any black powdery deposit which is really gold. A bath that is to be used repeatedly should be frequently filtered, as the presence of any organic matter in it is likely to throw down the gold, and when once it is thrown down, the bath may be at once rejected.

Rapid Paper Prints.—If these prints refuse to tone, the cause probably is that the iron of the developer has not been thoroughly washed out of the paper, and that it throws down the gold from the toning solution. If, however, attention be paid to the directions given, this defect should not arise. In the writer's experience the paper varies a good deal in its amenability to the toning process, some brands toning more readily than others, and indeed some batches of the same brand taking much longer to tone than others. If it be found that the prints take very long to tone, the amount of gold chloride should be increased, and the temperature should be raised *a little*, but should never be allowed to exceed about 65°, because a gelatine surface, even when it has been treated with alum, is not insoluble in warm water till it has once been dried.

Gelatino-Chloro-Citrate Prints.—The writer has never had any trouble in toning these prints except when the toning bath has been too weak. Here, of course, the remedy is evident. Some, however, have complained that they have

difficulty in toning the prints. Ashman has told the writer that where such difficulty exists, it may be overcome by soaking the prints before toning for a few minutes in a bath of sulphocyanide of ammonium of a strength of, say, 20 grains to the ounce.

The Prints Tone, but the Tone is more or less Lost in Subsequent Operations

Albumenised Paper Prints.—This is a very annoying defect, and one of by no means infrequent occurrence. The tone is all that could be desired in the toning bath, and then, when the prints reach the fixing bath, behold the lovely tone vanishes, and gives place to a dingy hue which can scarcely be described, but which all printers are sure to become only too familiar with at some stage of their experience. It sometimes happens that the tone, lost when the prints first enter the fixing bath, is regained after they have remained there for a few minutes. This *may* be due to sulphur toning, but I believe it merely marks the completion of fixing.

One cause of loss of tone in the fixing bath undoubtedly is insufficient washing before toning. Another is acidity of the fixing bath. These two cases have already been discussed, and the remedy is moreover self-evident. Too *strong* a fixing-bath may be another cause of falling off, especially with certain brands of paper. The writer believes that the fixing bath for prints on albumenised paper should never exceed in strength 3 ounces to the pint.

Rapid Paper Prints and Prints on Gelatino-Chloro-Citrate Paper.—It has already been stated that a falling off of tone is a thing to be looked for in the case of prints on both these kinds of paper, and that it must be allowed for by pushing the toning operation further than would otherwise be considered necessary.

The Prints Tone Unevenly

With all kinds of silver prints there is one common

cause for this defect, and it is the failure to keep the prints in motion during toning. It is, of course, particularly liable to occur when the toning bath is very active, and the prints take but a few minutes to change colour. It may arise from fingering the prints too much, in which case the unevenness will be in the form of finger-marks toned *less* than the rest of the picture. Such marks, if on the back of the print, although very evident whilst the paper is wet, generally disappear when it is dry.

If it be borne in mind that the amount of washing which a print receives before toning materially influences not only the time taken by the process, but also the colour eventually got, it will readily be understood that, if the prints be not kept in motion during the washing which precedes toning, and if in consequence they are unequally washed, unequal toning will probably ensue.

The High Lights of the Prints are Yellow, not White as they should be

Albumenised Paper.—The defect generally shows itself only, or at any rate most, in such prints as show wide expanses of white, or of what should be white, as, for example, in vignettes.

It has already been mentioned that paper prepared on a neutral bath will keep but a short time, and that “preserved paper” will not keep for ever. Both turn brown in time, and it is of course not to be expected that pure white can be got from paper tinted to begin with. Still the tint which comes with keeping is greatly reduced during toning and fixing, and is altogether of a much less objectionable nature than that to be described presently. It should always be borne in mind, in connection with paper prepared on a neutral bath, that it will turn colour as much in the printing-frame as anywhere else, and that, if more than a few hours are likely to be taken in printing, the paper should be backed with “soda paper,” as already described.

The yellowness that is most to be feared is that known

as "sulphurisation," because it is supposed to be due to some sulphur compound. It very often appears in prints after a few years, and is then—wrongly, in the writer's opinion—termed fading. Unfortunately it sometimes appears during the processes of toning and fixing.

If the prints be allowed to stick together in the first washing water before toning yellowing is likely. They should be passed *rapidly* through the first water. Light during this washing or during toning, if sufficient to act on the prints, appears generally to produce the "sulphur-yellow" or something quite similar to it in appearance.

A slight trace of hyposulphite of soda in the toning solution may produce it, or acidity of either the toning or fixing bath, particularly the latter. I have already several times pointed out that the fixing bath should be slightly alkaline, and I now emphasise my remarks. When preserved paper is used, any acid which may be in it should be got rid of either by repeated washings or by the use of soda to neutralise it, as already advised.

Rapid Paper.—The prints on this paper are very liable to be yellow if due care be not taken. The cause generally is that the developing solution is used far too long, or that it is not rapidly enough washed out of the prints when they come from it. It is a considerable safeguard against yellowing to have the developing solutions acid as advised.

Bromide Paper.—Here again yellowness is probably due to the incomplete removal of the iron salts of the developer from the prints. The use of the acid baths recommended *immediately* after development, passing the print directly into the dilute acid without preliminary washing, will ensure absence of the defect, unless it is due to insufficient washing after the acid bath. Care must be taken to remove all the acid from the prints before they go into the fixing bath.

Gelatino-Chloro-Citrate Paper.—The only cases of yellowing of prints on this paper that have come within the writer's experience have been due to insufficient washing between fixing and treatment with alum, the alum evidently

throwing down some sulphur compound from hyposulphite of soda left in the paper. The remedy is evident.

The Prints Lack Contrast

Albumenised Paper.—Leaving out of the question the quality of the negative, which may of course be responsible for the defect, lack of contrast is generally due to the use of too weak a sensitising bath or to too short floating of the paper on a bath strong enough. There is generally, in this case, as well as the want of contrast, a defect termed “mealiness” or “measles,” which will be hereafter described.

Bromide Prints.—Generally over-exposure is the cause of lack of contrast in these, but it may be due to too strong or too old a developer. An oldish developer—one which has been used a few times, and has not been kept for *very* long, generally works very slowly, but tends to give strong contrasts; but if it be very old or completely worn out, it will fail to give contrast enough.

Rapid Paper.—Want of brilliancy in prints on this paper has always been due, in the writer’s practice, to over exposure, it being necessary to strike with some accuracy the mean between that short exposure which will give a heavy, greenish-black image, and that long one which will give a red—and consequently tonable—image, but one lacking in contrast. Mr. Urie, the inventor of an ingenious automatic machine for rapid printing, already described, has told me that better contrast results from a short exposure to a bright light than from a long exposure to a dull light.

The Shadows are Heavy and Lacking in Detail

Albumenised Paper.—The defect is always due to the negative, and the methods of treating the negative, so as to avoid the defect—if it (the negative) be not under-exposed, in which case nothing will improve it—have already been treated. Something may be done, as also mentioned before,

by sensitising this paper for only a very short time on the ordinary bath, or for a moderate time on a weak bath.

Bromide Paper.—The defect can be got over to a great extent with this paper by giving a *long* exposure and stopping the development—which will be very rapid—at a comparatively early stage, thus getting the necessary detail in the lights before the shadows are “blocked up.”

Rapid Paper.—The same may be said of prints on this paper as of those on bromide paper; but there is scarcely the same power of correction.

Gelatino-Citro-Chloride Paper.—As this paper tends to give vigorous prints even from thin negatives, it should not be used for those which show very much contrast, or the shadows are sure to be heavy.

Bronzing of Prints

Albumenised Paper.—The bronzing appears only in the shadows which, looked at from a certain angle, have a metallic lustre. Unless the bronzing is very marked, it will disappear in the fixing bath. If it makes its appearance to any very offensive extent, the sensitising bath should be weakened for the particular brand of albumenised paper that shows the defect.

Gelatino-Citro-Chloride Paper.—In the commercial brands the defect appears only when negatives of too strong contrast for use with this paper is used. Doubtless a modification in the preparation of the emulsion might result in a paper which would not bronze even with very strong negatives, but the writer has not enough experience on this point to be able to give information.

The Prints are Mealy

Albumenised Paper.—The defect consists in a mottled appearance of the shadows. It is generally due to lack of free silver nitrate on the surface of the paper, due to too weak a sensitising bath. The remedy here is self-evident.

It may also be due to the use of an acetate bath which has not been kept long enough before it is used.

Marks of Various Kinds on the Prints

It is manifestly impossible to give a description of every kind of spot or blemish which may appear on a print, but mention may be made of one or two defects of the kind which are particularly likely to be met with.

Albumenised Paper.—*Marble-like markings* are due to scum on the surface of the sensitising bath. *Round white spots* are due to air bubbles. *Metallic spots*—these are of any size from that of a pin-head upwards—are of irregular outline, and of a gray metallic lustre. They are supposed to be due to particles of iron in the paper or in the blotting sheets or boards with which it is dried. The spots are almost sure to make their appearance if the paper be left for a long time between blotting boards after sensitising.

Bromide Prints and Prints on Gelatino-Chloro-Citrate Paper.—Black streaks extending for a greater or lesser distance across the print are generally due to a trace of hyposulphite of soda on the fingers or on the edge of the dish. The *very smallest* trace of this salt is sufficient to produce the defect. The developing dish and the fingers of the operator should be very carefully washed before development is attempted.

CHAPTER XX

SILVER PRINTING—*continued*

The Treatment of Residues

EVERY photographer who works any silver printing process on any but the smallest scale will find it well worth his while to preserve the residues. Experienced photographers speak of savings of from 50 to 75 per cent of the total amount of silver used by very careful collection of all waste.

The residues are of several kinds. We may take—

1. *All Waste Sensitised Paper*.—Any piece of paper spoiled in whatever way, whether it has been printed on or not, should be saved. Trimming should, whenever possible, be done before toning and fixing, etc. This is possible in all but development processes where it scarcely is. If the bulk of paper becomes very large, it may be burned at any time, the ashes only being kept. A large flower-pot or any such vessel will do to burn in.

2. *Washings*.—The washings of all kinds of sensitised paper in which there is a soluble salt of silver are worth preserving. Thus the washings of plain or albumenised-sensitised paper, whether the latter have been sensitised at home or not, and of gelatino-chloro-citrate paper should be kept. There is, however, no use in keeping the washings of “rapid” or bromide paper. In any case only the first two, or, at the very most, the first three washings are worth keeping. They should be poured away into a large vessel of any kind, and the silver should be precipitated in the

form of chloride by the aid of common salt. The chloride of silver will gradually settle; when it has reached the bottom, it may be poured away, and the vessel is ready to receive the next batch of washing water.

(3) *Fixing Baths*.—All fixing baths are worth keeping, whether plates or paper have been fixed in them. If the photographer is in the habit of precipitating the silver from his plate fixing baths, he need do nothing more than mix the paper fixing baths with the plate fixing baths; but if he is not in the habit of so doing, the sooner he begins the better.

The fixing baths must be poured into a vessel separate from the washing water, and the silver is precipitated in the form of sulphide of silver with sulphide of potassium, or “liver of sulphur,” as it is commonly called.

It is well to have a vessel with some kind of a lid for the fixing bath residue solution, as the sulphide of potassium is an instable body, and gives off sulphuretted hydrogen gas, when it is in the solid form or in solution, and the smell is very offensive. The smell is useful, however, to enable us to know when to add more sulphide. Thus we may begin by pouring a solution of a few ounces of sulphide of potassium in a pint or two of water into a large vessel. It will smell strongly of sulphuretted hydrogen, and will continue to do so as we add used fixing baths till all the sulphide of potassium has been used up in precipitating the silver out of the hyposulphide of soda solution. Then the smell will cease, and we know that it is time to add some more sulphide of potassium solution. The sulphide of silver settles to the bottom in the form of a heavy muddy precipitate. As the vessel gets full, the water over the precipitate may be removed to make room for more fixing baths, care being taken to remove it only when the contents of the vessel smell of sulphuretted hydrogen, otherwise there will be some waste of silver.

Disposal of the Residues

Many silver refiners and such-like advertise that they

give full value for residues of all kinds, and the residues in the various forms already described may be sent straight to the refiner,—that is to say, the burned paper in the first case, the chloride of silver collected from the bottom of the vessel and dried in the second case, and the sulphide of silver similarly collected in the third case.

A great deal of trouble is saved by sending the residues right away to a reducer, and there can be little doubt that most reducers are honest, returning the full value of the residues, less the small fee that they charge for reducing. But it is equally doubtless that some are either dishonest or very unskilful, and that in such cases the return is very disappointing. There is, at any rate, always some uneasiness where there is no means of imposing any check on the refiner, and therefore many prefer to reduce their own residues.

With chloride and sulphide of silver—the precipitates got from the second and third kinds of residues mentioned—thoroughly washed and dried, there need be no uncertainty, as they contain a quite definite quantity of silver. Every ounce of sulphide of silver contains to within about a grain 7 drams of pure metallic silver, every ounce of chloride of silver contains almost precisely 6 drams of metallic silver. In calculating the money values of these residues, it must be borne in mind that, in accordance with the usual intelligence exhibited by us in the matters of weights and measures, we weigh *chemicals*, such as chloride and sulphide of silver, by apothecaries' weight—480 grains to the ounce, when we use them in the laboratory; we sell and buy them by avoirdupois weight, with $437\frac{1}{2}$ grains to the ounce, 16 ounces to the pound. Silver and other precious metals, however, we buy and sell by troy weight, again 480 grains to the ounce, but 12 ounces to the pound.

The following is one way in which the various residues may be treated if we wish to reduce them ourselves:—

Over the paper ashes, placed in a large evaporating dish, there is poured a quantity of a mixture of 1 part of nitric acid to 4 or 5 parts of water. The acid and water are

gradually raised to the boiling-point, and are kept at this temperature for some little time. The liquid will then contain most of the silver in the form of silver nitrate. It is separated from the ashes by straining through muslin; common salt is added to precipitate the silver in the form of chloride, and this chloride is added to that got by precipitating from the washings. The ashes are then treated with hyposulphite of soda solution to extract from them what silver may remain in them, and the hyposulphite solution is then added to the vessel for receiving old fixing baths.

We thus have all our residues in the form of either chloride or sulphide of silver, and can, as has already been indicated, readily check their value if we send them to the refiner, all that is necessary being to wash them by adding clean water, stirring up the precipitate with this water, allowing it to settle, pouring off the water, repeating this operation two or three times, then drying the precipitate on a piece of blotting-paper or filter paper. It is a custom with some not to treat the paper residues with nitric acid at all, but to burn it merely, and place the ashes direct in the crucible, with the flux, as afterwards described, for reducing silver chloride. In this case there is no way of knowing accurately beforehand how much silver the residues contain.

Those who have the use of a furnace may themselves reduce the salts to the metallic state in the following way:—

One part of silver chloride, thoroughly dried, is mixed with two parts of sodium carbonate, and one part and the mixture is placed in a Stourbridge clay crucible having a cover. Heat is gradually applied. After a bright red-heat has been reached, the lid is occasionally lifted. After a time it will be observed that the silver has been reduced to a metallic state. At this stage the sulphide of silver may be added. The crucible is now once more covered, and the temperature is raised till a white-heat is reached. The heat is kept up for about twenty minutes, when the process may be considered complete. The molten silver

may now be turned out into anything which will form a convenient mould for it to harden in ; or it may be turned into water, in which case it will be, as the term is, *granulated*, which means that it will be divided into small particles ; or it may be allowed to cool along with the crucible, and may be then removed by breaking this latter.

It is commonly considered an advantage to granulate silver, if it is to be used for the production of nitrate of silver, by dissolving it in nitric acid ; but I have been told that “cleaner” silver nitrate may be obtained by using the silver in a lump than by granulating it.

To Convert the Silver got from Residues into a Printing Bath

To produce silver nitrate, it is only necessary to dissolve the pure silver obtained by the operations just described in nitric acid, and to “recrystallise,”—that is to say, to continue evaporating the liquid obtained by dissolving the silver till the bulk has crystallised ; to pour away the small quantity of liquid that remains, which is to be mixed with the next batch to be evaporated ; to redissolve in water the crystals left after the residue is poured off ; to evaporate once more and to pour away—to go also into the next batch—a residuum of the second solution ; and finally to dry the crystals. The object of recrystallising is to get rid of all impurity, and especially of the last trace of free nitric acid, which would be objectionable in many cases where silver nitrate is used. In the case, however, of the preparation of a printing bath any small quantity of free acid may be neutralised, as hereafter described, and for that reason it is by no means necessary to go through the tedious process of recrystallising. The silver may be treated thus :—

A mass of silver is placed in an evaporating dish, and is covered with a mixture of 1 part of nitric acid to 2 of water. Heat is gently applied by the aid of a sand bath. It will be observed that an action is set up indicated by a certain amount of effervescence. This will by degrees subside, when a little more acid is added. The action is

thus kept up with the effect that the mass of silver will gradually be reduced. The addition of nitric acid should be stopped before the silver is entirely dissolved, the heat being kept up for, say, half an hour, after all action has apparently ceased. This will ensure a very close approximation to neutrality in the solution, but will probably leave it still slightly acid. The silver left is taken out, and is retained till the next time of dissolving.

We now have a very strong solution of slightly acid silver nitrate. This is diluted till it reaches the strength at which we wish to work our bath—50 grains to the ounce or whatever it may be. Estimation of the strength may be made in the way described in Chapter VIII., or by the use of the argentometer if it be preferred, as there is not enough of any foreign salt present to upset the reading of this instrument.

The addition to the new bath of a few drops of a solution of carbonate of potash in the manner already advised in Chapter VIII., for the purpose of keeping the bath neutral, will be sufficient to neutralise any free nitric acid which may be present. Enough of the solution must be added to produce a distinct precipitate.

To Precipitate and Redissolve an Old Sensitising Bath

It sometimes occurs that a sensitising bath “goes wrong” or breaks down in an unexplained manner even when all the precautions mentioned in Chapter VIII. have been attended to. In such a case the best course to pursue probably is to precipitate the silver in the form of carbonate, and to redissolve the carbonate in nitric acid.

This may be done in the following manner :—A saturated solution of pure carbonate of potash in distilled water is made, and this solution is poured into the bath which has broken down until the dense precipitate, which at first forms, ceases to be formed by further addition of the soluble carbonate. We now have all the silver at the

bottom of our vessel in the form of carbonate of silver, which, as has already been said, is insoluble in water.

It is necessary to wash this precipitate thoroughly. This is done by pouring off the superfluous fluid, adding distilled water, stirring up the precipitate with this, allowing it to settle, pouring off the water, and repeating the operation several times.

Pure nitric acid is now cautiously added to the wet precipitate. A violent ebullition is at once set up, and the precipitate is partly dissolved. The acid is added very slowly till the whole of the carbonate of silver has disappeared. We have now a solution which is almost precisely the same as that got by dissolving the metallic silver in nitric acid, as just described; indeed, except for the presence of slight accidental impurities, exactly the same,—that is to say, it is a strong and probably slight acid solution of silver nitrate. It is reduced to the required strength and neutralised in exactly the same way as the solution got by dissolving the silver. It is better to dissolve all the carbonate of silver with the nitric acid, and afterwards to produce a little more carbonate of silver by the addition of carbonate of soda, than to stop the addition of nitric acid a little before all the carbonate is dissolved, as in the latter case the silver carbonate is likely not to be in a fine enough state of division to act as a means of carrying down the organic impurities of the bath as described in Chapter VIII.

CHAPTER XXI

THE PLATINOTYPE PROCESS

THE platinotype process is one, the popularity of which increases daily, and that deservedly in the writer's opinion.

The distinguishing features of the process may be said to be its simplicity, the permanent nature, and the peculiarly artistic colour and general effect of the results.

Although the process is one of development, the image is visible in the printing-frame, and the manipulations during development and afterwards are so remarkably simple that perhaps, with the exception of the "blue process," platinotype may be set down as the simplest of all printing processes in its workings.

The permanent nature of the image is a very great point, and is one which must now be admitted on all hands. A long discussion has recently taken place on the subject. It was initiated by Mr. A. Pringle, who contended that sulphur in certain forms might attack the prints. The result of the discussion—during the whole of which, by the way, Mr. Pringle appeared to be entirely misunderstood by those who took up the opposite position—was to show that, although there was a remote possibility that the whites of the prints might yellow in circumstances where they would probably never be placed but for experiment, the actual image may be pronounced to be as unalterable as any image with paper as a support ever can be.

The colour of the image varies from a fine engraving black to a colour called sepia, and somewhat approaching

that tint. The surface is the natural surface of the paper, without glaze or "meretricious gloss" of any kind.

By most artist-painters and such-like, platinotype prints have from the first been declared to show great artistic merit; but it has taken a long time to educate the general public to turn from the well-known photographic browns and purples, with a glossy surface, to the colder blacks and the mat surface of the platinotype, but a change in taste appears to be surely coming about.

The following is, as briefly as possible, the general principle of Willis's process:—

Paper is coated with a mixture of chloro-platinite of potassium and ferric oxalate.

The ferric oxalate is sensitive to light, being by its action converted into ferrous oxalate. The result of exposing paper coated as described is therefore that, in the printing-frame, an image of ferrous oxalate is produced. This image is of a faint grayish orange colour, the unchanged salts being lemon yellow.

Ferrous oxalate has the effect when *in solution* of reducing chloro-platinite of potassium to metallic platinum. It is then only necessary to dissolve the ferrous oxalate in some liquid capable of dissolving it, when the solution will reduce the chloro-platinite of potassium to the metallic state as metallic platinum.

A liquid capable of dissolving the ferrous oxalate is to be found in a solution of oxalate of potassium. It is only necessary then to float the paper, having on its surface chloro-platinite of potassium, and an image in ferrous oxalate, on a solution of oxalate of potash, when an image in finely divided metallic platinum or platinum-black results. The action of the solution is rendered more energetic by heating it.

After development the remaining iron salts may be dissolved from the surface of the paper by any of several acids.

This process is patented in this country by W. Willis, jun., and is commercially worked by the Platinotype Company, who issue the paper ready sensitised, and the materials for sensitising it.

It would certainly be to the advantage of the general photographer to purchase either the paper or the materials for sensitising it ready-made, even if he were licensed to produce them himself. The writer, however, thought that experimentalists might care to try their hand at the production of the paper from the beginning, and had an idea of giving instructions for so doing; but after reading the best work on the subject,¹ and making a few experiments, he concluded that the work was only such as could be undertaken with advantage either by a highly-skilled chemist or by one who intended to go in for it elaborately and on a large scale, to neither of which would such instructions as could be given here be of much use.

I therefore proceed to describe the manipulation of the paper as purchased ready sensitised, and afterwards to the method of sensitising the paper with materials purchased from the Platinotype Company.

The point which must be most carefully observed in connection with the paper which is purchased ready sensitised is that it be kept absolutely dry. It is bought either in a "calcium tube" or in a roll of waterproof paper. In either case, it must be stored in the calcium tube. This consists in a long cylindrical box, having in the lid a space filled with asbestos, which has been soaked in calcium-chloride. The calcium-chloride absorbs moisture greedily, keeping the paper which is in the tube quite dry. When the calcium has absorbed so much moisture that it is perceptibly damp, it may be dried on a shovel or in an iron ladle over a bright fire.

It is necessary to take precautions against damp at every turning. Thus the paper in the printing-frames must be covered at the back with sheets of india-rubber, and the prints, when taken from the frames, must be returned to a calcium tube. There should be as little delay as may be in placing the paper in the frames and in taking it out. It is advisable—at any rate in very damp

¹ *Platinotype*, by Captain Pirzighelli and Baron A. Buhl, translated by the late J. F. Iselin, M.A., and edited by Captain W. de W. Abney, R.E., F.R.S. London: Harrison and Sons, 59 Pall Mall.

weather and especially when the film is unvarnished—to warm the negative in front of a bright fire just before the paper is placed in contact with it, as gelatine is quite perceptibly hygroscopic, and a negative film absorbs, in damp weather, quite enough moisture to affect a platinotype print during exposure. The result of damp is degradation of the whites of the print, and a general lack of vigour.

Exposure of the Paper

Platinotype paper is considerably more sensitive than sensitised-albumenised paper—probably about three times as sensitive. It must therefore be more carefully handled in the light.

The negative that is best suited for the production of platinotype prints is one having vigorous contrasts, as the contrast given by platinotype is as a rule somewhat less than that got on albumenised paper, the same negative being used in both cases.

The image is of a grayish orange tint. At first it is a little difficult to judge by examining it when the exposure is sufficient, but after a little practice it is very easy. According to whether it is decided to develop in a very hot bath or in a comparatively cold one (a question to be treated of presently), the exposure is continued till the shadows and half tones only are visible, or till all detail, even in the lights, can be distinguished.

Development of the Image

The developer for the prints is an aqueous solution of oxalate of potash. Within considerable limits the strength of this solution is not of consequence. It is therefore common to use a “cold saturated” solution.

The developer is always used more or less hot. The Platinotype Company and others advise that we give such exposures that development may be performed at a temperature of about 180° Fahr.

It is to be understood, however, that any temperature

between 100° Fahr. and the boiling-point may be used, the lower temperatures involving longer exposures, and some prefer to expose the longer time and develop at comparatively low temperatures, claiming that they thereby get pure whites with greater certainty, and that they have more control over the results.

In any case, the developer must be contained in an iron dish lined with enamel, and must be heated by the aid of a spirit-lamp, a bunsen burner, or any other convenient arrangement.

When the desired temperature is reached, a print is laid face downwards on the surface of the solution. If the temperature be high, development is almost instantaneous, but if it be low, say about 120° Fahr., as long as fifteen or twenty seconds may be taken. The developer may be used many times.

Fixing and Washing the Prints

The object of fixing or clearing the prints is to get rid of all iron salts which, if they remained in the film, would produce yellow discoloration. The clearing solution consists of a mixture of 1 part of hydrochloric acid with 60 parts of water. There should be made up three baths of this mixture. The prints go from the developing bath directly into the first of these baths, where they remain for about five minutes, being afterwards passed through the second and third baths. After they have left the last, they are washed for a few minutes, when they are finished. As soon as the first bath becomes deeply tinted with yellow, and in any case before the last bath shows *any trace of yellowness*, No. 1 should be thrown away, No. 2 substituted for it, No. 3 for No. 2, and a fresh No. 3 bath should be made up.

The prints will be found to dry without any tendency to curl up.

Brown Tones in Platinotype

The Platinotype Company sell a paper which gives a

fine brown colour of image. As the writer does not know wherein consists the difference between this and the paper prepared according to Mr. Willis's patent, he can only advise those who give the paper a trial to adhere strictly to the directions issued with it.

Sensitising of Paper

Pretty much the same may be said of sensitising of paper as of the production of brown-toned prints. The instructions received with the materials should be strictly adhered to. A word or two here may, however, not be out of place.

It is almost necessary to work by white light, as the yellow light from gas or oil lamp scarcely renders the yellow sensitive solution visible at all, so that by such light it is impossible to see whether the coating is even. The white light must, however, be *very* feeble compared with what may be used with sensitised-albumenised paper. This is for two reasons. The platinotype paper is considerably more sensitive than albumenised paper, but more than this, there is, in the case of platinotype, no action equivalent to the clearing action of the toning and fixing of albumenised paper, which will remove a slight tint existing before these processes are gone through. It is therefore necessary to be careful of light in a degree more than proportionate to the greater sensitiveness of the platinotype paper. Probably only about one-tenth as much light is permissible with platinotype as with albumenised paper.

For coating the paper a piece of soft sponge may be used or one of the damping brushes for copying-books made of felt or flannel, or a pad of cotton wool. In any case it is necessary to wash the sponge or brush in clean water at the end, say, of every quarter of an hour, and if there is any metal mounting on the brush, care must be taken not to let it touch the sensitising solution.

The paper, after being put on one side till the surface moisture disappears, which should be in from five to ten minutes, should be dried in a warm place (say near a coal

or coke stove), where a thermometer will stand at from 100° to 110° Fahr., and the time taken for drying should be about ten minutes.

Platinotype Prints on Linen and other Fabrics

Platinotype prints may be produced on almost any white fabric which will stand treatment with weak acid, etc., and the effects produced on some of these are exceedingly good. Various fabrics are sold ready sensitised by the Platinotype Company, and linen, etc., may be sensitised in the same way as is paper.

Pizzighelli's Printing-out Process

Recently Pizzighelli has worked out a process that differs entirely from that already described, inasmuch as it gives an image in the printing-frame that is visible in all details and that needs no development.

Briefly stated, this effect is brought about by combining the salts that are used both in the film and in the developer of the process of Willis, and by coating paper with the mixture, using some substance such as gum or arrowroot to prevent the mixture from sinking into the paper.

In Willis's hot bath process it is essential that the paper be kept absolutely dry, otherwise good results cannot be expected. The opposite would appear to be the case with the printing-out process. The presence of a small quantity of water seems to be necessary to enable the ferrous salt produced by the action of light to reduce the platinum. It is, therefore, difficult or impossible to get vigorous prints with absolutely dry paper. The amount of moisture that paper will absorb from the atmosphere in a comparatively short time, in all climates that are not abnormally dry, is, however, sufficient to insure success.

Pizzighelli's paper is now an article of commerce, and all who are interested in platinotype printing should, at least, give it a trial. It is, moreover, not very difficult to make. The process is certainly simplicity itself. The paper

is placed in the printing-frame, and is exposed till the desired depth of image is got. The exposure necessary is longer than that needed either in the process of Willis that has been described or in that that is to be described. The paper, as it comes from the frame, presents the appearance of a finished print but for the yellow colour of the lights. This is, however, immediately removed by the acid baths, which are made up and are used precisely as described for the hot-bath process. The prints, after coming from the acid baths and being washed, are finished and are ready for mounting.

For a full description of this process, see the *Photographic News* for November 18 and November 25, 1887, and for January 6, 1888.

Willis's "Cold-Bath" Process

This is the last outcome of the ingenuity of the original inventor of the platinotype process. It differs materially from the hot-bath process already described. In the first place, the platinotype salt is contained in the developing bath not in the paper; in the second place, the effect is more under the control of the operator than in the case of the hot-bath process; and, in the third place, the developer is, as is indicated in the title, used cold not hot, a detail that is by no means of essential importance, but that is, at least, of comparative convenience.

The paper in this process is coated with ferric oxalate only, or with that salt combined with a salt of lead or mercury, and the developer contains potassic oxalate, potassic chloro-platinite, and also sometimes a salt of lead or mercury.

Like the printing-out paper, absolute dryness at the time of printing is inimical to good results, but a fact that is of great importance is that the nature of the image got on development differs materially *according to whether the print is developed immediately after it comes from the frame, or is left for some time in the damp state to "age."* If the print be developed as it comes from the frame, it will give the

maximum of brilliancy, or rather contrast, and will therefore give a good print from a comparatively thin negative, but a hard print from a dense negative. If, on the other hand, it be kept, the image will be softer and become more full of detail the longer the time that is allowed to elapse, so that a harmonious picture can be got from a very dense negative—provided of course that all the detail is actually represented.

Dampness, as here spoken of, must not be supposed to mean actual visible dampness, but is used only in contradistinction to the state of extreme desiccation of the paper as it comes from the calcium tube. Paper taken from the calcium tube will, in an ordinary climate, become damp enough in a few minutes if simply exposed to the air.

The actual manipulations are as follows. The paper is taken from the calcium tube at least a quarter of an hour before it is needed, and is placed on one side. Willis recommends that as a matter of convenience several "flat boxes with hinged covers, of wood or of paper," be provided for the paper to "age" in either before or after printing. The process of actual printing is the same as that for the "hot-bath" process, but the exposure is a little shorter. If the negative be as thin as one as will give a good print, development should proceed at once. If, on the other hand, the negative is one that tends to give a hard print, the paper, as it comes from the frame, is set on one side to "age" for a longer or shorter time.

If a large enough number of prints are to be developed to justify the mixing of sufficient developer to well cover the bottom of a porcelain dish rather larger than the prints, it is best to develop by floating the print. The print is floated on the surface of the developer, is lifted up and is watched as the image gradually gains strength. After a few seconds it is floated again, is lifted and watched again, and is, if necessary, floated a third or even a fourth time. When only a few prints are to be developed at a time, Willis recommends the use of a broad camel-hair brush to spread the developer over the surface of the print.

After the development treatment with the acid baths and washing are as for the "hot-bath" process.

The materials for this process are sold by the Platinotype Company of London and other dealers, who coat the paper by machinery. I am told by Mr. Willis that all his efforts to work out a method of coating by hand have failed. It is to be hoped that the difficulty will be overcome, as it practically inhibits the use of the paper in countries far distant from the only place of manufacture.

Willis's patent may be seen in the *Photographic News* for January 27, 1888, and a very interesting paper on the process by Mr. Willis himself may be read in the *British Journal of Photography* for December 14, 1888. I cannot wind up my short description of the process in any better way than by quoting the last words of that paper.

"I will now state what appear to me to be the most important features and advantages of this process; they are—

"1. The pigment of which the image is formed is derived wholly from the developer, and, in consequence, the utmost transparency possible on a mat surface is attained.

"2. The operator has great power to modify his results; his success depends upon his skill, and he is not bound to an inflexible and fated result by the want of plasticity in his materials.

"In conclusion, I may be allowed to give an opinion as to the value of this method, and perhaps the strongest statement I can make is, that after working many years at the platinotype process, always with an ideal before me, I feel that my aims are at last as far satisfied as is permitted to those working in a world where all things are conditioned."

CHAPTER XXII

PROCESSES FOR COPYING PLANS OR OTHER DRAWINGS IN BLUE

THERE are certain processes which are almost exclusively employed for the copying of plans or other drawings, and which are most useful for such purposes. In the case of one of them, which is very simply worked, the copy is in the form of a negative,—that is to say, it shows as white lines on a dark blue ground. For most purposes such a drawing is practically as useful as a positive drawing. If, however, a positive drawing—one that is showing dark blue lines on a white ground—be desired, the second or third of the three processes to be described must be used.

The papers for either of the processes may be purchased ready prepared, and I may say that it will probably be found convenient so to purchase them unless work be done on a very large scale, and possibly even then, at any rate in the case of the positive processes.

For whatever process is used it is desirable that the drawing to be reproduced be traced on tracing paper, or better, tracing cloth, of as transparent a nature as possible, with ink as opaque as possible. A little yellow colour may with advantage be added to the Indian ink used for such tracings.

Where the process is regularly used, in workshops, etc., it is a common practice to omit the inking in of the drawing on drawing paper, and to make a tracing of it on very transparent tracing cloths to serve as the standard drawing

to be kept in the drawing office. This tracing then serves for the reproduction of blue copies for the shop, etc.

The best effect is produced if all shading (to indicate sections, etc.) be done with inked lines; but for rough work, as, for example, for detail drawings for shop use, colour may be used in the usual manner.

Although the best results are got by copying tracings, it is possible to get quite useful results from drawings even on thick drawing-paper, a very long exposure being given to compensate for the opacity of the paper.

By using the ordinary process—which gives a *negative* from a *positive drawing*—a positive is of course obtainable from an ordinary negative, and the blue colour of such positive is very effective for certain half-tone subjects; for example, some sea-scapes. The prints, unfortunately, have generally a somewhat “sunk-in” appearance; but the writer’s attention was attracted by some very brilliant blue prints in the store of Mr. Sam C. Partridge of San Francisco, and was told that the brilliant surface was obtained by the use of encaustic paste (see Chapter XXVIII. on Mounting Prints). The process has the advantage that any kind of paper may be used with it.

The Ordinary “Blue Process”

To produce paper for this process, the following solutions are made up:—

A

Potassium ferricyanide (red prussiate of potash)	5 ounces
Water	20 „

B

Ammonia citrate of iron	5 ounces
Water	20 „

The two solutions are kept separately. When paper is to be prepared equal parts of each are taken, and paper is coated with the mixture simply by laying it on a flat board,

and sponging the liquid over it with a clean sponge. As already mentioned, any kind of paper may be used, but for copying drawings a thin, smooth drawing-paper will be found to serve best. It is not necessary that the coating of the paper appear quite even so long as no parts are left bare.

The paper is hung up to dry and may be used at once, or at any time within a few days of its manufacture. The exposure is long, several times that necessary for a silver print. Exposure is continued till all the print but the lines assume a bronzed appearance, or, in fact, as long as possible without much discoloration of the lines.

The print after exposure is dipped in water, when the bronzed appearance turns to a bright blue, and the lines clear up. It is then washed till the water that comes from it is colourless, when it is finished.

It will be observed that drawings and tracings must be placed with their *backs* in contact with the paper, otherwise the images will be reversed.

Blue Positive Processes

Pizzighelli's Process

A

Gum arabic	.	.	.	.	3 ounces
Water	.	.	.	.	15 „

B

Citrate of iron and ammonia	.	1½ ounce
Water	.	3 ounces

C

Ferric chloride	.	1 ounce
Water	.	2 ounces

D

Potassium ferrocyanide (yellow prussiate of potash)	.	2 ounces
Water	.	20 „

E

Hydrochloric acid	.	.	.	2 ounces
Water	.	.	.	20 „

A, B, and C are mixed, and paper is coated with it as soon as possible, just as described in the last process. The exposure is very short, being only about half or one-third that necessary with sensitised-albumenised paper.

After exposure D is applied with a brush till the image appears blue on a white or bluish ground. If the ground be darker than very *light* blue, this shows that the exposure has been too short. The print is now dipped in E, which removes the slight tint from the ground and darkens the lines. It is washed and dried.

*Pellet's Process*A¹

Oxalic acid	.	.	.	1 ounce
Iron perchloride	.	.	.	2 ounces
Water	.	.	.	1 pint

B

Potassium ferrocyanide	.	.	3½ ounces
Water	.	.	20 „

C

Hydrochloric acid	.	.	2 ounces
Water	.	.	1 pint

A is the sensitising solution, B is the developing solution, and C is the clearing bath. The exposure is about the same as that for the last described process, and the manipulations are the same also.

¹ *Photographic News*, April 5, 1878.

CHAPTER XXIII

PRINTING WITH SALTS OF URANIUM

THE principle on which printing processes involving the use of uranium salts depend is almost exactly the same as that on which the "blue process" with iron salts depends. Just as ferric salts are reduced to the ferrous state by the action of light, uranic salts are reduced to the uranous state, and when in this state they have the power of reducing certain salts—nitrate of silver and chloride of gold, for example—to the metallic state, so that a film of a uranic salt may be used as a means of obtaining, indirectly, an image in metallic silver or gold. The process was apparently first conceived by Burnett in 1855, and published by him in 1857.

The uranium process is capable of producing prints that are, sometimes at least, of great beauty, and that are probably very much more permanent than silver prints on albumenised paper. Nevertheless the process is, I believe, not practised other than experimentally at the present day. For this reason a very short description will suffice here.

The sensitising solution is made up as follows :—

Nitrate of uranium	.	.	.	2 ounces
Water up to	.	.	.	10 „

Any good quality of plain paper is floated for five minutes on this bath and is dried in the dark. It is then ready for printing, but will keep for a considerable time

if protected from light. In the printing-frame an image that is of a dull gray, but that shows about all the detail wanted, is got. To get a silver print the exposed paper is immersed in a bath made up of—

Silver nitrate	.	.	.	.	$\frac{1}{2}$ ounce
Water	.	.	.	.	10 ounces

The image will very quickly develop or intensify. When it is dark enough the print is taken from the bath. The image will probably be of a very brown colour, but it can be toned to a good purple black in an ordinary gold toning bath. After this it is fixed in a solution either of hyposulphite of soda or of sulphocyanide of ammonium, and is washed.

To get an image in gold directly by development, a bath containing one grain of chloride of gold to each ounce of water is used in place of the nitrate of silver solution. The prints should be of a good black, and only need to be washed after development.

The "Wothlytype" Process

The process that bore the above name was the means of giving rise to great excitement and unlimited expectations when it was first announced as something entirely new in 1864. The process by no means fulfilled the expectations, and it lived for but a short time. The statement made in the first announcement that the process was one in which the use of silver salts was avoided was found, when details were published, not to be true, and unexpected difficulties were met with in the working. Nevertheless the process is at least worth mentioning, because it was, so far as I know, the first in which a film on paper, capable of giving a visible image, was prepared by coating with a collodion holding the sensitive salts in suspension.

The novelty of the process consisted in mixing the uranium nitrate and the nitrate of silver, using collodion as a solvent or medium. Paper was coated with this, and

gave, in the printing-frame, an image that needed no development, and that had only to be toned, fixed, and washed.

As has been said, the process was a failure, but it gave the idea to Wharton Simpson of the collodio-chloride process that has already been described.

CHAPTER XXIV

VARIOUS MANIPULATIONS IN CONTACT PRINTING

Treatment of the Negative before Printing and during Printing —*Treatment of Paper to suit certain Negatives*

THERE are very few negatives which will give perfect prints “right away,”—that is to say, placing them at once in printing-frames with paper behind them, and placing them to print in whatever light comes nearest to hand. Almost every negative is improved by a little hand-work of some kind or another, and there are not many which do not absolutely require it.

Of actual retouching, as it is commonly understood, I intend to say no word here. Those who wish to acquire this art may consult Mr. Robert Johnson’s book, which appeared in the same series as this book appears in.¹

The kind of defects which can be remedied without actual retouching with the pencil on the film side of the negative are such as show certain considerable portions of the prints too light or too dark. These defects may be only local, requiring that a certain light be either made lighter or darker, or that a particular shadow be made darker or be relieved, or they may be general, amounting in the latter case to either *hardness* or *flatness*,—that is to say, the negative is of such nature that it will give a *hard* picture, the alternative being, according to the time of

¹ *A Complete Treatise on the Art of Retouching Photographic Negatives, and Clear Directions how to Finish and Colour Photographs*, by Robert Johnson. Marion and Co.

printing, chalky lights without detail or deep black shadows without detail ; or is of such nature that it gives too soft or flat a print, the alternative being, according to the time of printing, shadows having no depth or lights far from pure white.

It must be understood that a negative which gives prints too hard or flat with one printing process does not of necessity do so with all processes. For example, a negative which will give a perfect print on paper sensitised on a neutral silver bath may give a soft or even flat picture in platinotype,¹ a hardish print on most brands of "preserved" albumenised paper, and a still harder one on gelatino-citro-chloride paper.²

It will thus be seen that it is difficult or impossible to fix a standard of density for a negative ; but we may arrive somewhere near it perhaps by first giving a description of a standard silver print, as it is commonly understood, and then stating under what conditions a standard negative will give such a print.

The extremes of lights and shadows in a perfect silver print should be represented before toning and fixing by an approach to white (a slight tint), and by bronzing (a sort of metallic lustre that appears on albumenised-sensitised paper when it is printed very deeply), and after toning and fixing by pure white in the *very highest lights*—and darkness as great as the paper is giving in the deepest shadows.

A negative which will give on albumenised paper, prepared on a neutral bath of fair strength (say 50 grains), such prints, when printing is allowed to go on in the brightest diffused light, may be termed a standard negative, and any departure from it will be termed too thin or too dense.

Although the standard above described is fixed entirely with relation to albumenised paper, and although it is true that every process will give from such a negative prints differing somewhat in range of depth as well as in colour, yet I think I am correct when I say that, granted a nega-

¹ See Chapter XXI. for description of this process.

² See Chapter XVII. p. 129, for description of this process.

tive with the extremes of transparency and density such as I have described, and having the gradation between such extremes good, it will be possible to get a good print from it by any process capable of giving a good print at all. I shall now suppose that the negative varies from the standard either one way or the other, and shall state how the best can be made of it, first treating of the ways whereby matters may be improved without treating the negative in any way, and afterwards describing various ways of treating the negative.

The Negative is too Thin

For such a negative paper floated on a strong bath and for the full time only should be used, and printing should go on only slowly, the frames being placed where there is a subdued light. Paper prepared on a neutral bath should always be fumed when thin negatives have to be printed from on it.

Some brands of "preserved" paper give stronger contrasts than does paper prepared in the ordinary way. Such paper may be used for thin negatives.

It should be observed that a little exposure of the sensitised paper to light at any time previous to fixing does much more harm in the case of that to be used (or which has been used) for printing from thin negatives.

Now as to the negative itself. I leave out all mention of intensification, because a description of such is out of place in a book on printing; but I cannot resist describing a process of great beauty whereby the effect of a moderate amount of intensification can be produced, and which may indeed be called a process for intensifying, but is, in the writer's opinion, best applied to the side opposite to the film. The method is an application of the powder or "dusting on" process. This process will be fully described farther on,¹ here I shall just point out how the process may be applied to the intensification of negatives.

If the side of a negative on glass, opposite to the film,

¹ See Chapter XXIX. p. 217.

be cleaned, be coated with the substance used in the powder process, be then placed film-side upwards in light, and be afterwards developed with powder, the result is a second negative on the front of the glass, which serves to augment the first. Moreover, the second negative is not quite sharp, and the result of this is to give a charming softness to the resulting prints. Further than this, there is great control over the results produced, inasmuch as it is possible to modify the *gradation* of additional density conferred as well as the amount. Thus, only a little additional brilliancy in the high lights is required ; a long exposure is given when the powder "takes" only on the high lights. On the other hand, if it be desired to bring up the half tones as well as the high lights, the exposure is made short so that the powder takes, more or less, everywhere but in the deepest shadows.

It is possible by skilfully managing the process to intensify locally with the very best results.

In the case of small negatives or even large ones where the glass is very thick, printing (through the glass) to act on the "powder" film should be done in direct sunlight, the negative being held with the plane of its surface at right angles to the rays of light. If the negative be large (say over whole plate) and the glass be not very thick, printing may be done in diffused light. The consequent loss of definition of the "powder" image will not hurt the final result.

In the case of collodion negatives the sensitive composition may be applied to the film side, the exposure being from the back. In this case the process is simply one of intensification, and is therefore without the scope of this work. I have heard of the process being applied with success to the film side of gelatine negatives, but have met with an obstinate staining of the film in my own attempts to apply the process thus. On whatever side the sensitive substance is spread, it must be protected by the application of a plate of glass.

Of course negatives, which have been treated in the way just described, must not be printed in direct sunlight.

When the method of local modification by working on tissue paper pasted to the back of the negative is treated, it will be seen that it is also applicable to the bringing up of high lights generally, although the process is of necessity somewhat tedious.

The Negative is too Dense, giving Prints which are Hard

If the negative be under-exposed as well as hard—if there be, that is to say, want of detail in the shadows—it is impossible to get a perfect print from it either by treatment of the negative or by any other method; but if the hardness be due merely to too great contrast, all the half tones being in their correct proportion, the only defect being in fact that they range through too great a field, then it is possible by due treatment of the negative, at any rate, to get perfect prints. But first, for what can be done by treatment of the paper. If the print be only a very little too hard when printing is done in diffused light, probably all the improvement necessary will be brought about by printing in the brightest possible direct sunlight.

A course frequently adopted with negatives that are just a little hard is to “sun” the paper before beginning to print. The operation consists simply in exposing the paper to light till it is very slightly tinted. One corner is covered with some opaque object—a penny, for example—or the paper may be held between the finger and thumb by one corner. The object is to have one portion not acted upon by light, so as to be able to judge how far the sunning has gone by being able to compare the tint produced with whiteness. If the negative be not much too hard—only giving prints very slightly hard when the frame is exposed in full sunlight—then “sunning” may have all the desired result; but if an attempt be made to overcome great hardness by excessive sunning, the results are sure to be bad. The paper should never have much more than just a visible tint on it.

Some photographers prefer to expose the back of the paper till the front is slightly tinted, claiming that they

thus get a better result in this case than sunning from the front.

If the photographer sensitise his own paper, he may get better results from dense negatives than he otherwise would by floating his paper only so long as is necessary to prevent it from giving mealy prints—that is to say, prints having a certain mottled marking in the shadows. An experiment may be made by floating for half a minute only. The paper must be quite damp before it is floated, otherwise it will not have ceased to curl before the floating is over. Paper to be used for printing from hard negatives should not be fumed.

Descriptions of methods of reducing negatives by chemical means belong to works that treat of the negative. I shall therefore here only say that, of the various processes in use, I much prefer that of Howard Farmer, in which a mixture of solutions of hyposulphite of soda and of ferricyanide of potassium are used. Let me repeat, however, what I have already said. If the negative be lacking in shadow detail and be also too dense in the lights on account of under-exposure, there is no use in attempting anything. It is only when the exposure has not been too short, and when the hardness is due to over-development, that the process to be described is of any value.

The writer has used experimentally, and with complete success, the single transfer process—to be hereafter described—for the purpose of reducing over-dense negatives by treatment of the back of the plate, in a way similar to that in which thin negatives may be intensified by the powder or “dusting-on” process. The negative film is first thoroughly hardened with chrome alum. A sheet of carbon tissue is squeegeed on to the back of it, is allowed to dry, is exposed through the negative, and is then developed in the manner usual with carbon tissue, and which will be found very fully described in the chapters on carbon printing.

As in the case of the powder process used for intensification, the operator has considerable power over the

gradation of the negative as well as over the extremes of contrast.

Local Modifications of the Negative

When it is necessary locally to modify a negative so as to increase artistic effect, the best plan is to place tissue paper at the back of it, gumming it on by the edges only, and to work on the tissue paper with crayon pencil and stump. It requires considerable artistic knowledge to do this effectually, but no very great manipulatory skill, as the work, being at a little distance from the film, does not print quite sharp.

It sometimes happens that a negative is faulty in that only one or two comparatively small portions of it are too dense, or even only one. In such a case the writer has proceeded with success in the following manner:—A piece of thick white blotting-paper is pasted on to the back of the negative, and with a damp finger those parts of the paper, opposite to the parts of the image, which are too dense, are gently rubbed down till, looking through the negative, with the paper next the light, it is seen that a harmonious result has been produced.

A negative so treated takes, as will readily be understood, a long time to print; but it gives excellent proofs if due care have been taken.

CHAPTER XXV

VARIOUS MANIPULATIONS IN CONTACT PRINTING—*continued*

Cutting the Paper

THERE are various manipulatory operations in connection with contact printing which must necessarily be described in such a book as this. It is true that most of these are not peculiar to silver printing, but are practised in connection with other kinds of printing as well, and that the description of them might perhaps be better placed after all contact printing processes have been considered than here; but I nevertheless incline to place the descriptions here, so that the work may form, leaving out the two first chapters and extending to the end of those on "various manipulations of contact printing," a complete set of instructions in the departments of printing which are commonly classed under the head of "silver printing," these being printing in chloride of silver on plain paper and printing in silver on albumenised paper. In the case of contact printing processes, to be described hereafter, if instruction given here do not apply, the fact will be mentioned.

Cutting up Paper

The cutting up of any kind of sensitised paper, so as to leave as little waste as possible, is naturally a matter of some little importance. For some reason best known to themselves, or perhaps not known at all, the paper-makers have forced upon photographers a standard size of sheet,

which is about as unmanageable as could well be conceived. This is 17×22 inches. Concerning the best manner of cutting up sheets of this size so as to avoid waste, I do not think that I can do better than quote Marion's *Practical Guide to Photography*, as I am not aware that the matter has elsewhere been gone more thoroughly into.

"It is desirable to have about $\frac{1}{16}$ inch margin for trimming in the case of every print, but beyond this the less there is the better. We give on following page a set of sketches showing how paper may be cut with the best advantage for different sizes. When the sizes are small there is no great difficulty in getting a very fair degree of economy. When they are large it is far more difficult. Indeed, for some large sizes the waste is excessive, *unless smaller sizes be worked at the same time*, in which case, by getting several different sized prints from each sheet, we may have fair economy.

"We take first of all the smallest size which is likely to be required, namely, carte. The smallest divisions in Fig. 1 give sufficient for trimming on all sides, and it will be found that there are forty-two of them.

"Next we take cabinets, as this is the size next in popularity to the carte.

"Fig. 2 shows how fifteen can be cut from a sheet. A strip 4 inches wide is first cut along one end of the sheet. This is divided into three pieces. The remainder of the sheet can then be cut up into twelve more.

" $7\frac{1}{4} \times 4\frac{1}{2}$ is a popular size for landscapes. The dark lines in Fig. 1 mark out nine pieces which are a little larger than this. A strip cutting into six cartes will remain.

"Whole plate, or $8\frac{1}{2} \times 6\frac{1}{2}$ inches, is as near as possible double-cabinet size. The thick lines in Fig. 2 mark out six whole-plate prints, leaving a strip cutting into three cabinets.

"A sheet cut into four, as in Fig. 3, gives 10×8 prints, with some waste, but not very much.

"One of these 10×8 squares will of course cut into four 5×4 squares, as shown in one of the top squares of

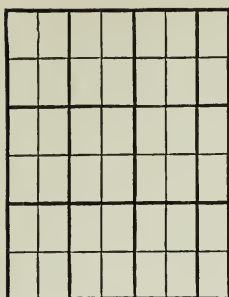


FIG 1.

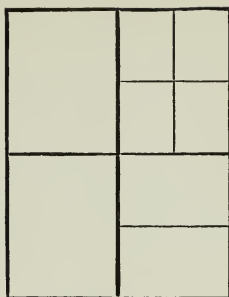


FIG 3.

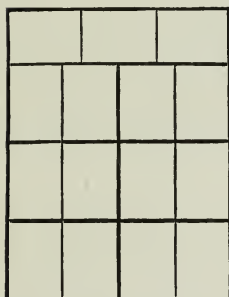


FIG 2.

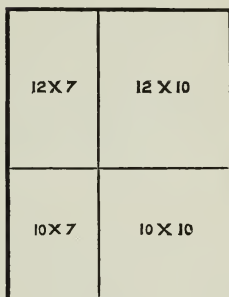


FIG 5.

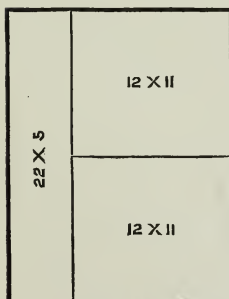


FIG 4.

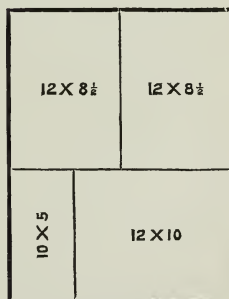


FIG 6.

the figure ; by cutting such a square in *two* as in a lower

corner two 8×5 or $7\frac{1}{2} \times 5$ prints are got, there being in the latter case, however, a considerable margin of waste.

"The most troublesome size of all is the 12×10 . In fact, if no size but this be required from a sheet, the waste is excessive. In this case the manner of cutting shown in Fig. 4 is the only one to resort to.

"The size 12×10 is, however, too nearly square for by far the majority of subjects, and a print of that size will, as a rule, be improved by cutting away from 1 to 2 inches of the width. The same refers to 10×8 prints. Fig. 5 shows one good way of cutting up a sheet when both 12×10 and 10×8 prints are needed. It will be seen that there is one full size 12×10 print got. Another is 12 inches long but only 7 inches broad. The size will be found to give a very good picture from many 12×10 negatives. It may be cut down to 10×7 and make a somewhat narrow print from a 10×8 negative. There is another which without any further cutting is 10×7 , whilst there is one 10 inches square which will serve for a full-sized 10×8 print.

"Where 12×10 negatives are being printed from but no 10×8 ones, the method of division shown in Fig. 6 will be found very useful.

"There is one full-sized 12×10 print got; two are of the preferable size, $12 \times 8\frac{1}{2}$; and there is left a piece of paper which may be used for a $7\frac{1}{2} \times 5$ and a carte, or for a $7\frac{1}{4} \times 4\frac{1}{2}$ and a carte, or for a cabinet and two cartes."

No mention is made here of the size 15×12 , which is one not very uncommonly worked since the introduction for general purposes of dry plates. Of this size, however, it is only necessary to say, that there will scarcely ever occur a case in which the picture will lose by cutting down the width to 11 inches, making the size 15×11 (15×10 will in most cases give a still better result), and that for this size there is no very great waste in cutting a sheet breadth-ways into two equal portions.

Various attempts have been made to persuade manufacturers to change the standard size of paper to 24×20 , but so far as the writer is aware without success, on this

side of the Atlantic, at any rate. The advantages of such a size over 17×22 are obvious. The sheet would cut without any waste into four 12×10 pieces or six 10×8 . Seeing there is always a little loss round the margin of a negative, 8×6 is a very fair size to print from a whole plate negative ($8\frac{1}{2} \times 6\frac{1}{2}$), and of these twelve could be cut from the sheet. Twenty cabinets could be cut with scarcely any loss by dividing the length into four parts and the breadth into five. Forty-eight cartes-de-visite could be got with but little waste by dividing the length into six, and the breadth into eight.

There appears, however, but little chance of our at all speedily getting a sheet of albumenised paper 24×22 ; but this size has latterly been adopted by the Platinotype Company, whose productions will be referred to in connection with platinotype printing.

In cutting up sensitised or albumenised paper care should be taken to finger the surface as little as possible. This is indeed a remark that applies to the process at all stages.

CHAPTER XXVI

VARIOUS MANIPULATIONS IN CONTACT PRINTING—*continued*

Vignetting

THE vignetting of prints is not very difficult, and is an operation which for a certain class of effects gives very pleasing results.

The art of vignetting dates from 1853, in which year a simple method of performing the operation was described by Mr. Latimer Clark. Mr. Lionel Clark has shown me a print on which is a note stating that it was produced in the year mentioned, and that it is undoubtedly the first vignettted photograph produced. As such it is interesting, but it would certainly, in the present day, be considered a poor specimen of the printer's art, the shading off being abrupt and irregular in form.

When vignetting first became at all fashionable, and when the effect of shading off to pure white at the edges of the print was very much admired, a great mystery was made of the manner of production, and the secret was sold for large sums, and this in spite of the fact that the process first described by Latimer Clark was perfectly feasible, and is, in fact, the one practised at the present day. The inexperienced probably imagined that the fine results got by skill and practice were due to some secret process. It would have astonished the photographers in those days not in the secret—and perhaps some of those in it—if they had been told that in the future perfect vignettes would be produced by the simple and apparently

crude expedient of printing through a hole in a piece of brown paper ; yet such is the case. The various appliances in this way of vignetting glasses, etc., which were once exceedingly popular, are going greatly out of fashion. Not because they are not useful in certain cases. They are. But because with care and skill as good results can be got by the use of a hole in any flat, thin opaque substance as by any vignetting glass or such appliance ; whilst to produce really good all-round work it is necessary to make each negative a study, and to modify the shape of the vignetting aperture according to the nature of the picture—a thing scarcely possible where vignetting glasses, etc., are used.

Vignetting glasses, it should be explained, are plates of glass which have a non-actinic “flashing”—generally of a ruby colour—over the whole of the surface except an oval or pear-shaped part of the centre. This part is clear—the flashing having been dissolved away by hydrofluoric acid—and there is a shading off between the clear part and the rest of the plate.

Such glasses are very handy when it happens that one is at hand, the opening of which is of precisely the right size and shape, and this is the case sometimes, especially in landscape work, where it is desirable to have a perfectly oval-shaped—or, more strictly speaking, elliptical—picture.

Before giving details of the manipulations in connection with vignetting, a word or two should be said as to the character of picture that will stand the treatment ; for it must be understood that by no means every negative, even of such that will give good pictures, will give an artistic vignette. It is a very common error with beginners to vignette every picture indiscriminately. They find that to vignette—in the sense of producing a shading off of the picture—is so easy that they are charmed with the process and apply it to every negative they have. Now I think it is not too much to say that only about one out of four or five negatives is suitable for making a vignette from, and that when it is, the utmost care and discrimination are

necessary in either selecting a suitable board or glass, or in making and using one.

A picture distinguished by softness and delicacy, and in which there is much small detail of a "sketchy" nature, if I may use the word, is, so far as I can judge, the kind that is suitable for vignetting. Often a negative all but spoiled by over-exposure gives an excellent vignette; whilst one in which there are strong and bold contrasts and effects of light and shade—especially if the shadows somewhat predominate—is unsuitable. One thing that appears to entirely disqualify a picture for vignetting is a large mass of shadow reaching the border of the vignette, which, were the picture not vignetted, would extend into the place occupied by the white margin in the vignette.

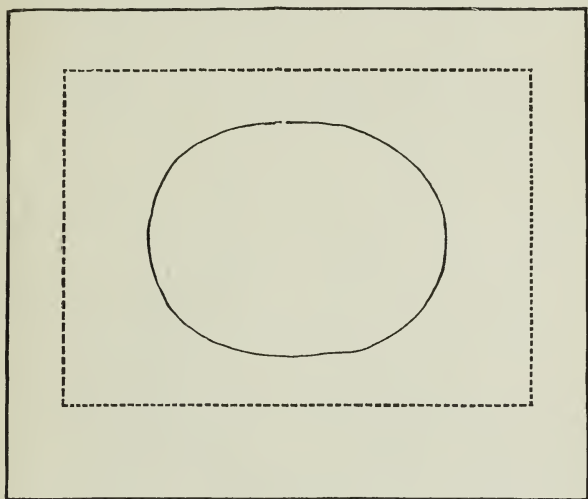
And now for the actual manipulations. I shall suppose in the first place a very simple case—namely, that in which a perfectly elliptical picture is needed from the central part of a soft landscape negative,—that is to say, where it is not necessary or even desirable to suppress a little more of one side than of the other side of the negative, a little more of the top than the bottom, or of the bottom than the top.

A vignetting glass, with an elliptical clear space somewhat *smaller* than the required image, is taken, and is fixed in any way at a distance of about quarter of an inch in front of the negative. In the case of the common form of cheap frame it may simply be laid in front of the frame; but the mistake must be avoided of supposing that the gradation of the tinted glass is sufficient, and of consequently placing the glass directly in front of—in contact with, that is—the negative. It appears to be impossible to so finely shade off glass that the mere printing of the shading gives a good vignette. It is necessary to give some additional shading by the diffusion of light.

The frame with vignette glass is printed in diffused light, in shade, that is to say, every operation of printing being conducted in the usual manner. The effect will probably be somewhat improved by fixing a piece of tissue paper in front of the glass. This remark applies

whether a vignetting glass or any other arrangement be used.

Any flat opaque body, such as a thin board, with a hole cut in the middle of it and fixed at a little distance in front of the negative, will give a result just about as good as that to be got by a vignetting glass. Thick paste-board, or even brown paper, is often used, a sheet being simply fixed to the printing-frame with gum or drawing-pins. But undoubtedly by far the most convenient thing



is that recommended by Mr. Lionel Clark. He suggests the use of very thin sheet-lead. This is exceedingly convenient, as the lead can be fixed to the printing-frame simply by bending over the edges, and the effect may be modified at will by bending, up or down, the edges of the opening.

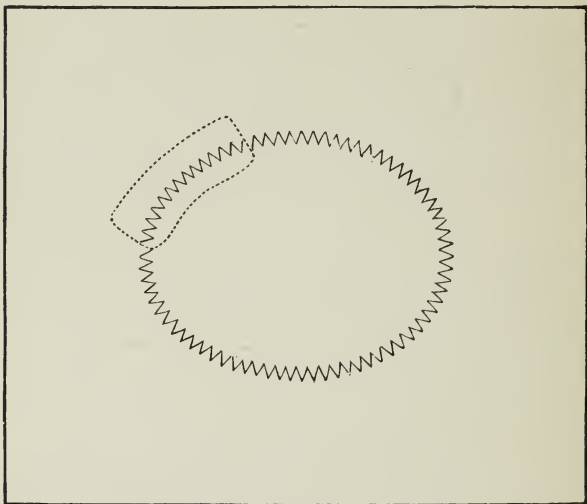
Whatever is the material of which the vignetter is made, if the gradation be required to be somewhat abrupt, the opening is simply roughly cut, as shown in the diagram.

If it be wished to make the gradation more soft, the vignetter may be placed somewhat farther from the negative, or, if sheet-lead or pasteboard be used, the edge of



the oval is bent upwards with the finger and thumb so as to raise it farther from the glass. An attempt has been made to illustrate the manner of doing this in the above cut, which is supposed to represent such a vignetter cut in half.

A third, and an excellent method, is to serrate the edge



of the oval as shown here. The serrations may be made deeper the more gradation is required.

Yet another way of bringing about the desired object—a very soft gradation—is to cut the hole in the opaque mask somewhat larger than it would be cut were no special means of softening to be adopted, and to gum on to the face of it several sheets of tissue paper, cutting through

each an aperture concentric with the larger aperture,—if we may be allowed to use the term for a figure which is not a circle,—but a little smaller either than the opening in the opaque screen or in the sheet of tissue paper which has been gummed on just before it. In some vignettters, made commercially, this plan is followed out, and the edge of the opening in each sheet of tissue paper is serrated. This appears to be almost an unnecessary refinement, but certainly, if such vignettters happen to be of just the right size and shape, excellent results are obtained.

In the early days of vignetting use was made of cotton-wool to a considerable extent, the wool being gummed or otherwise fixed to the inside of the opening in the opaque screen. So far as the writer knows this plan is but little used now, but he has found cotton-wool useful at times to check the tendency that there is, when the attempt is made to vignette certain subjects, for some part of the image to spread beyond the general outline of the vignette. When this tendency shows itself and cannot readily be checked, by fixing a little bit of paper to the inside of the opening—as will be presently explained—a little cotton-wool may be pushed lightly in between the edge of the opening of the vignette and that part of the negative which tends to print beyond the proper boundary.

So far we have only considered the case of a vignette which is elliptical in outline ; but it happens very frequently—almost always in the case of portraits—that a perfect ellipse is not the best shape of vignette. Of course this is a matter in which the taste of the operator will show itself very greatly ; but it may be said that the outline of the opening of a vignetter suitable for a portrait is very often something approaching a pear-shape, the wide end of the opening being downwards. The outline must, however, somewhat follow the outline of the figure.

I again borrow a cut from Marion's *Practical Guide to Photography* to illustrate the matter. In this a dotted line shows approximately the shape of opening that would be required to vignette a certain figure.

Whilst on the subject of the vignetting of portraits, I

should say that the general characteristics of a portrait negative to be vignetted should be the same as those of a landscape negative—softness and delicacy—and that besides special attention should be paid to the background. The commonest background to use for a vignette is one which prints off a uniform light tint (not quite white, however) ;



but it is by no means necessary that it be uniform. Any background which is the reverse of conspicuous, which has no tint deeper than a half tone, does well for a vignette. The thing to be particularly avoided is a dark background, or one of a pronounced type. A blanket placed so far behind the sitter as to be quite out of focus, generally makes a good background for vignettes.

Even if the best of skill be exercised it is seldom,

except when the conditions are very simple, that a suitable vignetter can either be selected or made so as to give results altogether satisfactory without a little "dodging." Generally the first proof will show that either a little too much of the subject is cut off at some place, or that it extends too far somewhere, or both defects are exhibited. If the subject is too much cut off anywhere, all that is necessary is to turn up the edge of the vignetter a little over the particular place, or to tear a little of it right away. If the subject incline at any point to extend too far, a piece of paper may be gummed to the edge of the aperture, filling in a part of the latter; or if this plan is not efficacious, a little cotton-wool may be inserted between the edge of the opening of the vignetter and the negative as already described.

It is always a good thing in vignetting to print through tissue paper, but it is specially so when the subject is a difficult one.

In the case of a difficult subject it is sometimes necessary to take several proofs, and to modify the vignetter after each before a perfect result is got. It need scarcely be said that any spoiled pieces of paper—so long as visible prints can be got on them—are good enough to make trials with, and that when a vignetter well suited to a particular negative is got after several trials, it is a thing not to be thrown away till the operator is sure that he has got all the proofs that he needs off that negative.

In the case of processes that give invisible or very faint images in the printing-frames, for example, gelatino-bromide and platinotype, it is advisable to use common sensitised paper for the one or two proofs that must be taken before the vignetter is properly adjusted.

It is sometimes wished to print the image right up to the edge of the plate in vignetting, and to allow the white margin to extend beyond the limits of the negative. For example, it may be desired not to lose any of the picture at either end of a 12×10 plate. In this case a good result will be got by printing the image on to the centre of a piece of paper 14×10 inches, or even a little larger,

allowing the outside of the shading (or the beginning of the pure white) to be just over the two ends of the negative. If an attempt be made to produce such a vignette in the ordinary way, with no special precaution beyond placing the negative in an extra large printing-frame, it will be found impossible to avoid printing the edges of the negative, which will show as dark lines beyond the image—in what ought to be the pure whites of the margin. By the following very simple arrangement the writer has been able to get over the difficulty:—A piece of non-actinic paper is taken. The outside is cut to the size of the print that is needed or larger. From the centre is cut a piece about quarter inch smaller each way than the negative. For example, if the negative be 12×10 , the opening in the mask is cut to about $11\frac{3}{4} \times 9\frac{3}{4}$. This leaves a margin of about one-eighth inch for fixing the mask to the negative. The mask must be fixed with strong glue to the *film* side of the negative. The negative is then laid against the plate glass of a frame at least as large as the outside of the print required. The mask may be used to temporarily fix the negative to the plate glass by gumming the paper to the latter. The printing of vignettes may then go on in the usual way, the shading being if desired carried right up to the edge of the mask. The cut opposite shows the negative and the mask. A is, of course, the negative, B the mask. The dotted line shows the edge of the negative; the inner full line the inner edge of the mask.

Reversed Vignettes

The reversed vignette, or vignette with a dark border, was at one time very much admired, and is still sometimes to be seen. It wants very considerable skill to produce such a vignette, unless the negative be specially prepared for it. The objection to so preparing the negative is that it requires a special arrangement in the camera, and that a negative, when so specially prepared, is not suitable for any purpose except the production of reversed vignettes.

The manner of operating in the camera is as follows: An arrangement is made so that vignettters, consisting simply of pieces of stiff cardboard or board with openings in them, can be placed in the camera between the lens and the ground glass, and so that the distance between the lens and the vignetter can be so adjusted as to give the requisite softness to the edge of the shadow of the latter on the ground glass, the softness being greater the nearer the vignetter is to the lens and the larger the stop. The background should be dark. The camera is then so adjusted that the image of the figure on the ground glass



falls into the proper position relative to the shadow of the vignetter.

It will be quite evident that where the shadow of the vignetter protects the edges of the plate, causing them to be transparent after development, the margins of the paper will print black.

One way of printing reversed vignettes from ordinary negatives is as follows:

An ordinary vignette is first produced in the manner already described. The print so got (of course before toning and fixing) is placed behind a plate of clear glass in an ordinary printing-frame. A piece of stiff cardboard of the size and shape of the image of the vignette (that is

to say elliptical, or of a shape something approaching this) is cut out, and is fixed at a little distance over the image so as to protect it, whilst the margins of the print are left unprotected. It may be secured by gluing a piece of cork to the plate of glass over the centre of the image, and gluing the cardboard to the cork. The height of the cork must be greater the softer is the vignette. When the arrangement described has been made, the frame is placed in diffused light till the margin has printed quite black, when the proof is ready for toning.

Some prefer not to vignette at all to begin with ; but to produce the reversed vignette direct upon an ordinary print, exposing till the image at the margins is completely obliterated, and indeed a little longer, otherwise the details in the dark margin will be liable to reappear to a slight degree during toning and fixing, producing a very unpleasant effect.

Vignettes with Tinted Margins

In some cases it is preferable to have the margins of a vignette tinted rather than pure white. This tinting is effected in the first of the two ways already described for producing a reversed vignette from an ordinary negative, but that the exposure of the margin is only carried on for a few minutes till a slight tint is got in place of till the margin is black.

CHAPTER XXVII

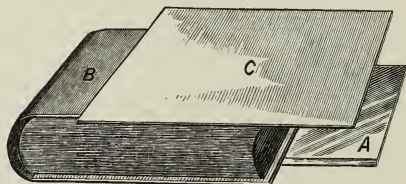
VARIOUS MANIPULATIONS IN CONTACT PRINTING—*continued*

Skies—Composition Printing

No landscape having any artistic pretensions whatever should have a perfectly white sky, or indeed, except in very few cases, should it have a sky of one uniform tint. The production of a sky generally requires a separate printing, because landscape negatives scarcely ever show any trace of cloud. It is true that with the new orthochromatic plates this defect may perhaps be remedied to a very considerable extent, but probably it will always be at least a common practice to put in a sky artificially, or to print it from another negative.

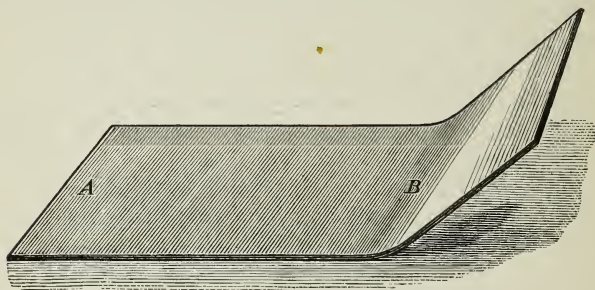
The last-mentioned way of producing skies is the commonest and, moreover, the best. It constitutes the simplest form of composition printing. I shall, however, first describe some other methods which are sometimes made use of for producing skies. The first is for making a graduated sky merely. It may be used when the sky prints quite or nearly quite white. In a few instances it produces a really good effect; but the best that can be said for it in most cases is that it gives a result somewhat better than a plain white or evenly tinted sky. It is made simply by exposing the print to the light with the lower or landscape portion covered, and with some arrangement whereby a gradation of tint is produced, getting darker towards the top. This may very well be done by laying the print under a sheet

of clean glass, placing a thick book or other similar object over it, so as to shade the landscape portion, and then a sheet of cardboard or some such object over the book pro-



jecting beyond the edge of it over a portion of the sky. The cut will explain the arrangement. A is the sheet of glass with the print under it; B is the book, or similar object; and C is the piece of cardboard. Of course printing must be done in diffused light. Care must be taken to allow C to project so far beyond the book that the front edge of the latter will not cause an abrupt mark on the print.

Some operators prefer to use a piece of bent sheet-metal, as shown on the accompanying cut, laying the part



A directly on the sheet of glass; but the writer prefers the arrangement just described, as it gives greater latitude of result.

With a sky that prints a uniform tint, clouds may be put in by hand on the back of the negative, if the operator have skill enough. He may do this either by colouring

direct on the negative or by stretching a sheet of tissue paper over it as already described in Chapter XXIV. p. 172, the clouds being produced on this paper with charcoal and a stump. To produce an effect at all good and natural requires considerable artistic knowledge and skill, but once a sky is put in as described, there is the great advantage that printing may be proceeded with at once, no second operation being required to produce the clouds.

If a sky prints with a tint, and it be determined to print clouds into the proofs from it by the aid of a separate cloud negative, it is necessary—unless the tint be only *very* slight—to block out the sky. This may be done with Bates's black varnish and a small camel's-hair pencil. A steady hand is required, but there need be no great difficulty in doing the thing, as any varnish which has gone over the line between sky and landscape can be taken out by rubbing with a rag dipped in a little benzine. Care must be taken not to allow the varnish to run into a thick ridge next to the outline of the objects, otherwise there will be blurring of the print from want of contact between the paper and the negative. When the outline is carefully painted in, the rest of the sky may be quickly blocked out with a larger brush.

Prints with white skies being once produced, it is necessary to select suitable cloud negatives for printing into these skies. I cannot here enter into the question of the production of such negatives. I can only say that, in the selection of particular clouds for a certain landscape, the photographer must be guided, as in so many other cases, by his artistic taste. Of course he will avoid such outrages as the use of clouds lighted from one side with a landscape lighted from the other, or of clouds taken near the sun with a landscape lighted from nearly in front, or from one side.

If the skyline be nearly straight the same plan may be used in printing in clouds as in producing a graduated sky,—that is to say, the print is placed behind a sky negative, being so adjusted that the clouds fall into suitable places, so as to “compose” with the rest of the picture. The

two are placed in a printing-frame, which must be of considerably larger size than either the print or the negative, so as to allow of the free adjustment of the former with regard to the latter, without danger of having the paper folded at the edge of the frame, and the picture part of the print is shaded with a book or such like object, and a piece of cardboard. This method is only possible when the horizon line is nearly straight, or when only black or nearly black objects extend into the sky. It is the practice of some photographers to print clouds right across even comparatively light objects, such as a church spire, printing in the clouds only very faintly; but the practice is one by no means to be recommended.

With subjects where what I may call the "graduating method" would have the result that the clouds would be printed over parts of the subject which are comparatively light in shade, the best way of working is to begin by making a "mask" to protect the landscape. The easiest way of doing this is to make a print—which may be on any piece of spoiled sensitive paper, and to cut very carefully round the line between the sky and the landscape. The landscape portion of the print, untuned and unfixed, is then attached to the sky negative, albumenised side next the film. The fixing may be done by a drop of gum at each of the lower corners of the print, so adjusting the position of the negative and the mask that the clouds left uncovered are suitable for printing into the proofs. In cutting the mask care should be taken that, if an error be made at all, it be made in cutting away a little of the landscape rather than in leaving any of the sky, and this for the reason that, if the sky a little overlap the landscape, the overlapping is scarcely noticeable, whilst, if even the thinnest line perfectly white intervene between the landscape and the sky the effect is conspicuous, and is conspicuously bad.

In adjusting the print against the masked negative, the same precautions must be observed. The sky must be made to overlap (a little) the landscape, rather than leave a space between the landscape and the sky.

It will be readily seen that when a print has been arranged behind the sky negative, it may at once be put out to print in any light, and without any further shading. There need be no fear that the clouds will print through the mask, as the whites of this latter quickly blacken by the light, till the paper is quite opaque. But although no shading is necessary, it is generally advisable to shade to a certain extent, so that the sky may print somewhat more lightly at the horizon than at the zenith, and this for the reason that the sky—in this country at any rate—generally appears brighter or whiter near the horizon than nearly overhead.

Where the special printing-frames made to facilitate composition printing is described a little farther on, it will be at once seen that where it is wished to print skies into a number of similar prints which need the landscape to be marked out, such frames will save much trouble, as the most difficult part of the operation, without a special frame, consists in adjusting, with precision, the print behind the mask, or perhaps rather in preventing it from shifting its position whilst the back is being applied to the frame.

Composition Printing

Composition printing consists in making a picture, different parts of which are printed from different negatives, of which there may be two—as in the very simple case of the printing of skies into landscapes—or many, a dozen, for example, in cases of very complicated figure subjects.

The object of composition printing is to make photographic pictures which, on account of the limitation of the powers of the lens, etc., cannot be produced at one time. I have read that the great master of photography as an art, O. G. Rejlander, who was the first, or one of the first, to use composition printing successfully, was led to make use of more than one negative to produce a photographic picture when, on attempting to carry out an idea he had of a group which involved figures both behind and in front

of a sofa, he found it impossible to get both into focus at one time.

Rejlander worked in the days of wet plates, when exposures were comparatively long unless large apertures of lenses were used. At the present time such a difficulty as that described would be got over by *forcing* the figures into focus, by using a small stop, a thing possible with the very rapid modern plates. And the possibility of using small stops is a reason why composition photography is practised less than it once was. It has other uses, however, than merely getting over the difficulty of focus. For example, it permits of figures being taken in the studio where there is a possibility of modifying the lighting, and of being printed into landscapes. It also enables figures, taken in the studio, to be printed into interiors where the exposure, even with modern plates, would put portraiture quite out of the question. In fact, it has many uses ; but the writer's object is rather to describe the mere manipulations which have to be gone through rather than to discuss the subject generally, or from the artistic point of view. He advises those who wish to study the latter side of the subject to take up Abney and Robinson's book on silver printing,¹ where it is treated very fully.

I shall suppose first of all the simple case where it is desired to print a single figure into a landscape. A print is taken of the figure on a piece of sensitised paper. With a very sharp pen-knife the figure is cut out, keeping very closely to the outline. The result is two masks : one of the figure, which may be attached to that part of the *landscape* subject which it is desired the figure should occupy, the other mask of all but the figure. This latter is used to cover up all the figure negative except the figure only. It is thus only necessary to print the figure first and to adjust the figure print carefully behind the landscape negative, when a composition is produced. It will be at once evident that a group of figures, which in the photograph run into each other, can be treated in the same way, or a

¹ *The Art and Practice of Silver Printing*, by H. P. Robinson and Captain Abney, R.E., F.R.S.

number of figures each on a separate negative, the figure negatives being masked out all but the figure, in the way that I have described—or by the use of black varnish as described for skies, if it be preferred—and the places in the landscape to be occupied by the figure being protected by the cut out prints of the figure.

Let us now go one step farther and suppose that it is desired to print a sky into the already composite subject. All that is necessary is to block out the sky of the landscape negative, and to sacrifice one composition print of landscape and figure or figures for the production of a mask for the sky negative selected. It is assumed that the upper part of the figure intercepts the horizon line of the landscape. The cutting of the mask is along the horizon line and round that part of the subject which projects above it. The mask is attached to the sky landscape as already described, and the sky is printed in just as though there were a landscape without figures.

There are many other “dodges” in connection with composition printing, but it is very difficult to explain them without an illustration showing the effects. In the book of Robinson and Abney, mentioned above, there is an excellent example of a composite print from six negatives. The subject is a particularly difficult one, and the description of the method of printing, accompanied by a photographic copy of the actual result, is most interesting.

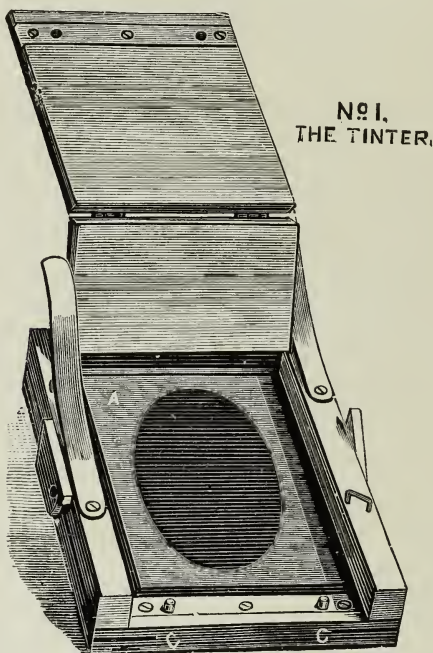
The only manipulatory difficulty that is likely to be met with in composite or combination printing is in accurately adjusting the print behind the second (and perhaps third, fourth, etc.) negative. I therefore describe a special frame which assists in the adjustment of the masks, makes the adjustment of the print under the various negatives a matter requiring no skill at all, and, moreover, makes it possible, if the first adjustments be made with ordinary sensitised paper, to make composition prints on films that show no visible image in the printing-frame, as, for example, in the case of carbon work.

I here give a drawing of the frame.

It will be seen that the frame does not greatly differ

from an ordinary one except inasmuch as there are, at one end, and beyond the negative, two punches marked *c, c*.

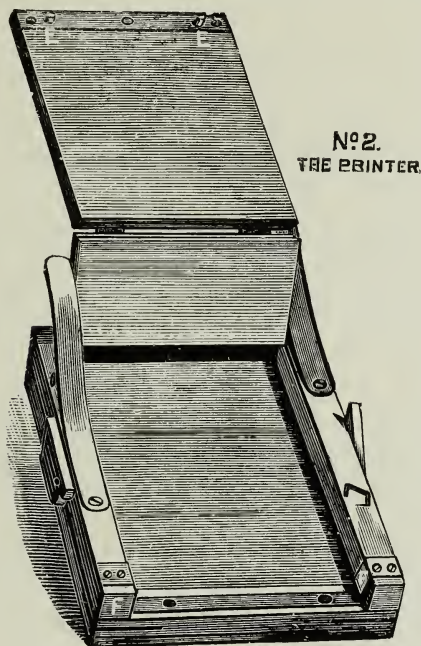
I shall now describe the method of using the frame—or frames rather, for one is needed for each negative used in printing a composite—and premising the description by saying that the frames must be all of the same size and



somewhat larger than the largest negative that has to be used for the composite, and that, for the convenience in working which the frames bring about, it is necessary to pay in some waste of sensitive paper.

I take again the very simple case in which it is wished to print a figure into a landscape. The figure landscape is fixed in the centre of one of the frames by the aid of strips of paper and glue. A piece of sensitised paper of the

whole size of the back of the frame is now placed in position, and the back being brought down, two holes are thereby punched in one end of the piece of paper. After printing, the figure is carefully cut out, as already described. A second frame is now taken, and the landscape negative is placed in it. The mask representing every-



thing except the figure is now placed on this frame with the albumenised side next the film of the negative, the punches of the second frame being made to pass through the two holes made in the mask by the punches of the first. The negative is adjusted under the mask till that part of it (the negative), which represents the space that is to be occupied by the figure, is under the opening in the mask.

The mask is now removed, and the negative is fixed down to the plate glass of the frame by strips of paper or otherwise. The mask is readjusted over the landscape negative, *the mask representing the figure* is adjusted over the landscape negative by the aid of the mask *representing all but the figure*, by making it fall into the place from which it was cut, and is gummed down to the surface of the negative.

Printing may now proceed quite mechanically. Paper is cut to such a size that it will, when placed in the frames, project over the punches. The mask representing all but the figure is placed on the figure negative by the aid of the punches. A piece of fresh paper is placed over it and the figure is printed. The print of the figure is then placed in frame No. 2, making the punches of this frame pass through the holes of the paper produced by the punches of frame No. 1, and the landscape may be at once printed in. It will be evident that this principle may be extended to any number of negatives, a self-registering frame being used for each.¹

¹ The frame just described is known as "Hemery's Patent Automatic Self-Registering Printing-Frame." There would appear to be something redundant in this high-sounding title ; but any way the frame is an ingenious and useful article.

CHAPTER XXVIII

MOUNTING PRINTS

Mounting Albumenised Paper Prints, Platinotype Prints, etc., in the Ordinary Way

UNDER the above heading comes the mounting of prints made by any of the true photographic processes that have already been described, except such as have been dried in optical contact with glass. These latter—for example, prints on “rapid paper,” on gelatino-chloro-citrate paper, and Lambert-types—need to be treated in a somewhat special manner.

The favourite mountant amongst photographers appears to be starch. The writer prefers to use a thin glue made up of gelatine ; but if the photographer prefers to use starch, he may use it in precisely the same way as is to be described for the gelatine solution. The objections to the starch solution are, that if it get sour either before it is applied to the back of a silver print, or afterwards in the case of the print and mount being exposed to dampness, the permanency of the image is endangered ; and further, that any spots or streaks of starch allowed to get on to the face of the print are more difficult to remove than similar spots or streaks of gelatine, and make much more conspicuous marks if left.

A gelatine solution is made up as follows :—

One ounce of hard gelatine is softened in ten ounces of water, and heat is applied to melt it. This forms a glue which is of the right consistency.

The way of mounting must vary a little when there is but a narrow margin, such as in the case of cartes and cabinets, and when there is a broad margin, such as is generally the case with landscapes. In the first case, the position of the print on the mount may readily be adjusted by the eye; in the second case, it is necessary to mark it.

Taking the case of the narrow margins first. The mounting solution is made very hot—not very far short of the boiling-point, in fact; if it be only slightly above its melting point, it will set on the print before the position of this has been properly adjusted on the mount.

The back of a print is quickly brushed over with the mountant, and is placed on the mount. For a few seconds after it first touches the mount its position may be adjusted by sliding. Whenever it has taken the right position, it is covered with a piece of white blotting-paper, and the ball of the hand is pressed over this latter to squeeze out all excess of mountant, or by a few strokes of the squeegee the same is effected. In either case any excess which may have come from under the print, and which may lie on the face either of the print or of the mount, is immediately removed by lightly rubbing with a sponge dipped in clean hot water.

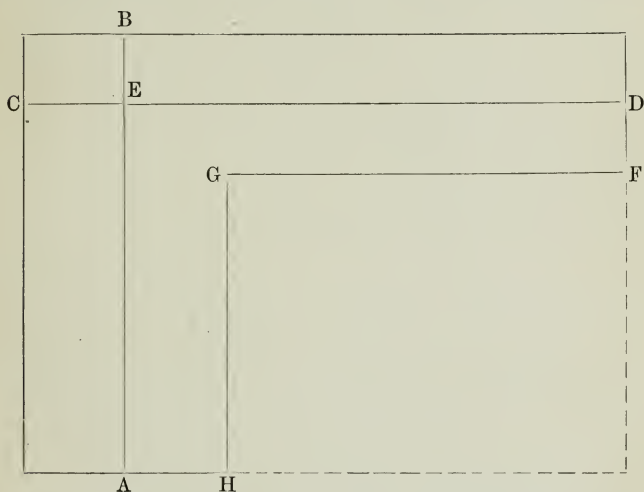
When prints are to be mounted with wide margins, it is necessary to mark the position to be occupied by two of the corners on the mount. When a number of prints of the same size are to be mounted on cards of the same size, a gauge for marking may be made in the following manner:—

A sheet of smooth stiffish paper is cut to the size of the mount. Out of one corner of this is cut a piece the size of the print. This leaves an L-shaped piece of paper. Each leg of this L is now folded longitudinally in half.

The figure will show the manner of cutting and folding. The dotted part represents that which is cut away. The lines A, B, and C, D are those along which the paper is folded. E, D, F, G, H, A is the shape of the figure that will be thus made.

To mark the mount the corner E of the gauge is placed

at the upper left-hand corner of the mount, the lines E, D, E, A along the edges of the card. G is now the position to be occupied by the upper left-hand corner of the print. It is marked by a light dot. The lower right-hand corner is marked in a similar manner. It is well, after the points have been marked by the aid of the gauge, to mark a cross with a needle-point through each, so that the position of the point will be indicated even if the corner of the print



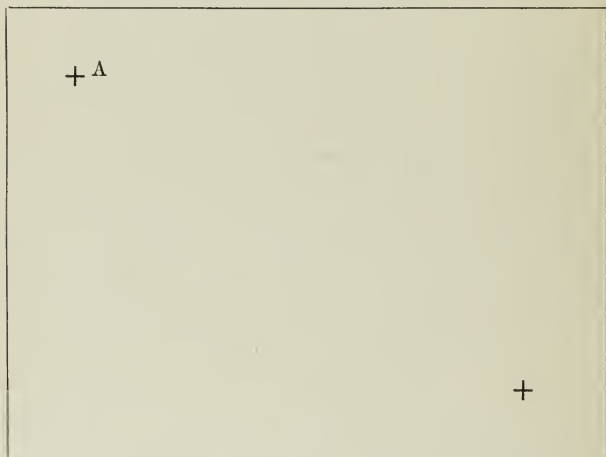
cover it. The following cut, in which A and B are the two needle-point crosses, will explain what is meant.

When, as is very often the case, there is a number of prints of various sizes, which have to be mounted on boards all of the same or of various sizes, there is nothing to be done but to mark each board separately by hand. This is a thing that can very easily be done by the aid of a T-square. A needle-holder, such as is frequently included in a set of mathematical instruments, is a very convenient thing to have for marking the boards.

The boards having all been marked, a print is brushed on the back with glue as described, is taken by the right-

hand top corner and the left-hand bottom corner, and is lowered towards the mount. The paper is allowed to bag or sag somewhat downwards, when the two free corners can be brought just to the two marks on the board. The two corners held in the hand are now allowed to drop. It will of course be perceived that if two of the corners be properly adjusted, the other two are bound also to be in the right position.

The excess of glue is now squeezed from between the



print and the mount, and is washed away as already described.

If this process is very quickly performed, so that the print has barely time to get wet through, the cockling of the mounts will be but small. If, however, any considerable time elapse between the time of gluing the print and adjusting it to the mount, the cockling will be considerable.

It is likely that some may prefer to apply the glue to the mount rather than to the print, damping the print, and submitting to the cockling of the mount, which may be removed by subsequent rolling or burnishing. This method of mounting is the easiest of any, but has the disadvantage that, on account of the unequal expansion of the paper

(greater in one direction than in another), a slight amount of distortion is brought about which may be appreciable.

To mount after this manner, the prints are placed in a dish of hot water, the mount is brushed thickly over with the gelatine solution, the print is applied, the excess of gelatine is removed by the application of the squeegee direct to the print, and the edges are wiped clean with a sponge.

Various alcoholic and other mountants which do not cockle prints at all are sold, and some of them are excellent. For a time a solution of rubber in benzine was very popular. It is very convenient. The mount and the print are simply covered with the solution, and the two surfaces are brought into contact after the benzine has partially evaporated, when they adhere. There is no cockling, and the operations are very simple; but I believe it has been found that after a time the rubber "perishes," and the prints strip from the mounts.

The alcoholic solutions have not the objection mentioned, and are to be highly recommended for small work. There is difficulty in using them for large work, as they set very rapidly when cool. This tendency can generally be overcome by adding water to them, but then the "non-cockling" properties are lost in part or altogether.

A good alcoholic mountant may be made as follows:—

An ounce and a half of gelatine is soaked in 4 ounces of water till it is soft, when it is melted by the aid of heat; $\frac{1}{2}$ ounce of glycerine is added, and then 10 ounces of strong methylated spirit, the last-mentioned being added at two or three operations.

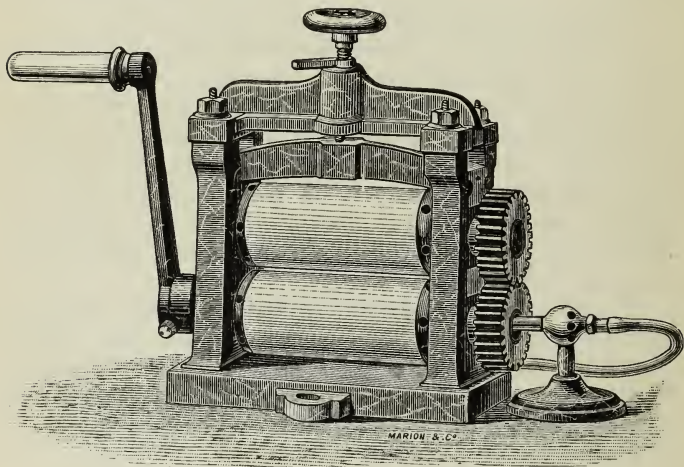
Dry Mounting

This is a term generally applied to a way of mounting introduced by A. Cowan, in which the print is applied with a dry mountant to a wet board.

The prints as they come from the washing water are laid face downwards in a pile on a large plate of glass. A solution of starch, such as would be pretty thick if cold, is made up, and some of this is brushed with a stiff brush

on to the back of the topmost print. This print is now laid on one side face downwards to dry, when another is treated in a similar manner. These prints will dry with scarcely any perceptible curling or cockling.

In mounting a card is damped, the print is brought into contact with it, and the two together are passed between the rolls of a rolling machine, when they will be found to



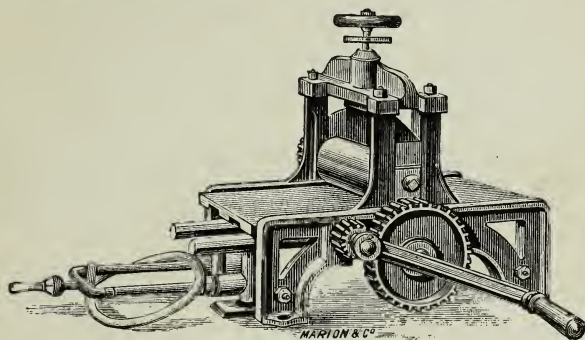
adhere, and there will be no trouble in the way of bending or cockling of the mount.

Rolling and Burnishing Prints

Almost every kind of print mounted as has been described is improved by rolling, whilst albumenised prints are greatly improved—or at any rate receive a gloss which some consider a great improvement—by passing them through a burnisher.

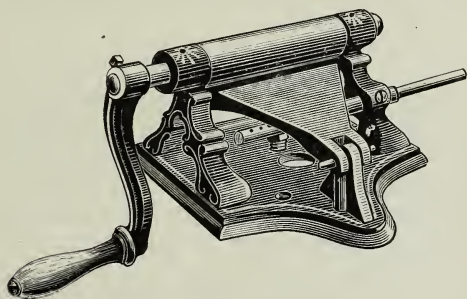
Rolling machines consist either of two rollers or a roller and a plate. The former form of machine is commonly used for small sizes, the latter for large. To give the best effect the plate or one of the rollers is heated. Rolling

machines are generally provided with arrangements for heating the part with gas or otherwise. In rolling pigment prints or any into which gelatine enters as a component, great care must be taken to have the image very dry before it is allowed to touch the hot surface. In fact,



it is well to dry it in front of a brisk fire before letting it pass through the machine.

Burnishing differs from rolling in that in the former the surface of the print is *rubbed* against or *scraped over* a



polished surface in place of being rolled between two such surfaces. The burnisher is always used hot. It is, as a rule, applied only to prints on albumenised paper. The burnisher is heated with gas or a spirit-lamp. The gloss obtained is higher than with a roller, but more skill is needed in working. The prints before they are burnished

should be rubbed over with a solution of 3 or 4 grains of Castile soap in an ounce of methyated spirit, a piece of flannel being used. They lie till they are quite dry, and are then passed several times through the machine, enough pressure being put on to pinch the card pretty tightly. If the surface of the prints tears, it shows (1) that the surface of the burnisher is out of order; (2) that too much heat has been applied; (3) that too much pressure has been applied; or (4) that the soap has not been properly spread over the face of the print.

Any fault in the burnisher will readily be recognised by the fact that scratches or marks of tearing repeat themselves in the same places on print after print. The burnisher may be repolished by applying an oil-stone to it.

If the burnisher do not give a sufficient gloss, it is because there is too little pressure, or the heat is not sufficient. If the surface of the burnisher is in good order, a very considerable heat—just such as will not scorch the paper—may be used, and so much pressure that it is fairly hard work to turn the handle. Burnishing in this way gives a *very* high surface, and generally improves the tone of the print considerably, making it a good deal warmer than it was.

Encaustic Paste

The object of the use of encaustic paste is to give a surface something like that given by the burnisher. Its use has greatly gone out of fashion lately, probably because the use of the burnisher has superseded it. It may, however, be found very convenient, and especially to those amateurs who do not possess a burnisher. The process consists in covering the surface of the print with a thin film of wax. The famous photographer, Adam Salomon, was the first to popularise the use of encaustic paste, and I therefore give precedence to his formula, although it seems in practice to give results little if at all better than the very simple one that follows it:—

Pure white wax	.	.	.	1	ounce
Gum elemi	.	.	.	10	grains

Benzine	$\frac{1}{2}$ ounce
Essence of lavender	$\frac{3}{4}$ „
Oil of spike	1 dram

These ingredients are mixed by the aid of heat. The second formula is—

White wax	1 ounce
Spirits of turpentine	1 „

A little of the encaustic paste or waxing solution is taken up on a piece of flannel, and is rubbed over the surface of the print, which is then polished with a second clean piece of flannel till it assumes a burnished appearance.

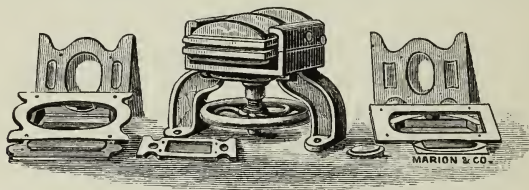
*Mounting Prints that have been Dried in Optical Contact
with Glass*

Those who have read the description of the “rapid printing” process, of the process of printing on gelatino-citro-chloride paper, and of the Lambert-type process will remember that it is advised, in the case of each of them, to dry the prints in optical contact with glass. If this be done, there are objections to mounting the prints in the usual way, as a great part of the gloss obtained by the particular manner of drying is thereby lost. It is true that if one of the alcoholic mountants already mentioned be skilfully used, the loss of brilliancy is but slight; still if it be desired to keep the full gloss, it will be well to have recourse to a special method of mounting.

When the prints can be mounted behind cut-out mounts there is a very simple method of proceeding. A little margin is allowed in printing, and the print is fixed to the mount by this margin only, which is afterwards hid by the cut-out mount. The effect is greatly increased if the print is *embossed*, the space behind the embossing being filled with a little cotton-wool to prevent the print from flattening out again. The embossing is done by the aid of a special press such as is illustrated here. It can be fitted with dies of various shapes and sizes to suit different subjects.

The best way in which to mount prints, such as those at present under consideration, is, however, to fix the mounts to the prints whilst the latter are still damp on the glass. If the actual mount be very thin, it itself may be fixed to the print. The print is allowed to dry till it is no longer wet but only damp. It is then brushed over on the back with a mounting solution made of gelatine, the card is quickly applied, and the two are kept in close contact by pressure for an hour or so, after which they are laid on one side till the print has dried through the card, a process of course taking time. This method is troublesome in various ways, and is, moreover, only applicable in the case of very thin mounts. A better method of proceeding is as follows:—

A little margin is allowed the prints before they go



through the various processes up to that of mounting. Very thin cardboard of good quality is cut to a size a trifle smaller than the prints. These latter are now as before allowed to dry till they are merely damp. One of these very thin cards is now brushed over with pretty thick mounting solution, and is applied to the back of a print. It is kept in close contact by being placed under pressure for an hour, and is then allowed to dry. The two leave the glass together, are trimmed together, and are mounted together on any kind of mount by being fixed to it with stiff glue round the edges. The thickness of the cardboard in this case prevents the dampness of the glue from hurting the surface.

Enamelling Prints

Prints such as those just treated of,—that is to say,

those dried in optical contact with glass, are said to have an "enamelled" surface. It is not at all difficult to treat prints on albumenised paper in such a way that a similar effect is produced. All that is necessary is in fact to dry such prints in optical contact with glass when the desired result is produced, and the writer has enamelled prints by the simple process of rubbing French chalk over the surface of a plate of glass and squeegeeing a wet print on to it; but this is a very uncertain process, the print commonly either leaving the glass before it is dry or refusing to leave it when it is. The following is a very satisfactory method to use:—

Plates of glass a little larger than the prints are cleaned and are polished with French chalk. They are then coated with plain collodion (a special cheap collodion sold as enamel collodion is particularly suitable), the plates are washed till all apparent greasiness has disappeared, and then the print is squeegeed wet on to it. The print readily strips off when dry.

Another way of working which some prefer is as follows:—The plates are coated with collodion as described; but in place of being washed are allowed to dry. The prints are placed in hot water. A plate is carefully levelled collodionised side upwards, and a warm solution of gelatine, 20 grains to the ounce, is poured over it. A print is taken from the warm water and is laid face downwards on the gelatine, care being taken to enclose no air bubbles between the two surfaces. The excess of gelatine is squeegeed away, and the plate is set on one side to dry.

It will be understood that if it be wished to mount such prints, they must be mounted in the way already described for other prints that are dried in optical contact with glass.

Mounting Prints in Optical Contact with Glass for Rims, etc.

This is a way of mounting which is very popular with some. It has the effect of giving a print on albumenised paper, or with a gelatine surface, a wonderful brilliancy

and transparency of shadow. The process will very readily be understood if I say that, in any of the cases just described, where prints are *dried* in optical contact with glass, if special care be taken to *prevent* the print from stripping when dry, the desired result will be got. The French chalk and the collodion are left out in the case of prints on albumenised paper, the clean glass being simply floated with gelatine, the print being taken from hot water, placed on to the gelatine, squeegeed down, and set on one side to dry. If prints on rapid paper and on gelatino-chloro-citrate paper be mounted on glass, simply omitting the French chalking, they will probably adhere, but there can be no certainty of this as the aluming gives a surface which does not adhere very readily to glass. If, therefore, it be desired that they remain in contact with the glass, they should be cemented down with gelatine solution as described for albumenised paper.

A very effective positive on glass is made by developing a carbon image on plain glass by single transfer, as for a transparency, but giving less exposure, and backing the image with white paper by flowing it with gelatine solution, and bringing the paper into contact with it.

It is to be observed that if the best results be wished patent plate should be used, that brown tones generally give the most pleasing results in optical contact with glass, and that the best style of framing is a narrow rim of metal or of wood coming right up to the edge of the print.

CHAPTER XXIX

CARBON PROCESSES

The Powder or Dusting-on Process

THE process known as the powder or dusting-on process is, as I have already stated, the oldest of all carbon processes. It was designed for use with paper or other supports, but was never, so far as I know, very extensively used with flexible supports, and, leaving out of the question the intensification and reproduction of negatives, is now only used for producing what are known as opalotypes—opal glass being the support, and occasionally transparencies.

The general principle of the process has been already described. The appliances required are of the very simplest. Indeed, besides the dishes and so forth needed for fixing, the only essential is a large camel's-hair brush of the mop form. The larger the better, but one of about $1\frac{1}{2}$ inch diameter will suffice for all except work of extraordinary size.

The Powder

As regards the powder to be used, I believe that any colouring matter in the form of a very fine powder will do. The process having been intended as a permanent process, a colour consisting essentially of carbon was at first looked for, and was readily found in two different forms,—namely, lamp-black and plumbago, both nearly pure carbon. The finest quality of lamp-black or of ivory black may be used.

Plumbago is best adapted in colour to the reproduction of negatives. That sold as the finest quality of "levigated graphite" only should be used for the powder process; but in fact the operator may select his own colour from any of those that are kept at the colour shops in fine powder, bearing in mind that it is an essential that the grains of the powder be really small, and the smaller the better.

The Transparency

It is of course understood, at any rate it has been stated in previous chapters, that in working the powder process a negative is got from a negative, or a transparency from a transparency. The fact that a negative may be got from a negative is one well worth bearing in mind, as the powder process offers an excellent means of producing reversed negatives, such as are needed for single transfer carbon printing and photo-mechanical printing, clear glass, instead of opal glass, being of course used where reversed negatives are to be made.

The transparency may be made by any process capable of giving good gradation, but the single carbon or transfer carbon process is much to be preferred to any other, as it gives a *reversed* transparency, and it is to be observed that if the transparency is not reversed the powder opal will be. The transparency may be produced in the camera if it be preferred, but a transparency taken direct by contact from a negative may only be used in these cases where reversal¹ is allowable.

It is to be observed further that the transparency must

¹ It is rather unfortunate that with photographers the term "reversal of the image" is sometimes used to mean two entirely different things: the one the reversal of position in the sense of making what was at the left side appear at the right side and *vice versa*, the other the reversal which arises from giving an enormously prolonged exposure when in place of a negative a positive is produced. It should be quite clearly understood that when we use the term in connection with any carbon printing process, we refer to the first of the two reversals mentioned.

be fully exposed, so that the details in the high lights are brought well out. The exposure that would produce a good lantern slide or a pleasing window transparency is a little too short to produce a good transparency for reproduction purposes, which should have little or no glass left quite clear, should in fact almost have what I have sometimes heard called a "mucked up" look when considered as an end, not as a means to an end. I have succeeded best with transparencies in which the contrast was but slight.

The Glass

As to the glass, that known as pot opal serves well. It is essential, to get the most artistic results, that it should be what is called "smoothed" on one side, although it might perhaps be better to call it roughened, inasmuch as the smoothing consists in giving the otherwise polished surface of the glass a grain like that of ground-glass.

The Sensitive Mixture

There is a multitude of formulæ for the powder process, almost any organic colloid body which is hygroscopic, and which is rendered sensitive to light by the addition of a certain amount of bichromate of potassium or bichromate of ammonium.

The following formula has the advantage of great simplicity, and has given results that are as good as could be desired.

Best quality of gum-arabic	.	.	80 grains
White sugar	.	.	60 "
Bichromate of ammonium	.	.	60 "
Water	.	.	7 ounces
Alcohol or methylated spirit	.	.	1 ounce

The solution will keep good for two or three days, and if it is not to be used for longer may be made up by dissolving the gum in the water by the aid of heat, adding the sugar, and, when the mixture is cool, the bi-chromate

of ammonium. The alcohol is added last. Its use is merely to increase the flowing qualities of the solution.

If the process is to be regularly worked from day to day, it is advisable to mix up a large quantity of the solution, leaving out the bi-chromate salt, and adding 2 grains of bi-chloride of mercury to each 10 ounces of the solution as a preservative. Mixed thus the solution will keep for a very long time, probably indefinitely. The bi-chromate of ammonium is added just before the mixture is wanted.

In any case the mixture must be carefully filtered before it is used. That just described being comparatively very thin may be filtered through common filter paper without difficulty.

Preparing the Plate

The opal plate is carefully cleaned with whitening and water, and is then flowed over with clean water. Whilst it is still wet, the sensitive solution is poured on to it so as to drive the water before it. A good deal of solution must thus be wasted, but this is not of very great consequence as the ingredients are very cheap. The excess of solution is now poured off, and the plate is carefully drained. A very thin film is all that is necessary to cause the powder to stick. A slight amount of unevenness of film does not of necessity produce unevenness of the final image.

The plate once coated has to be dried, and considerable heat is necessary to dry it. It may be placed in a hot oven, or in front of a bright fire, or, best of all, over a charcoal brazier. The heat should not be allowed to get so great that the plate cannot be touched by the hand.

The film is not sensitive whilst it is wet, but it is extremely sensitive immediately that it is dry—probably it is no exaggeration to say that in some cases at least it is thirty or forty times as sensitive as sensitised-albumenised paper. For this reason it is necessary to be careful to what light it is exposed.

The plate dry, and still hot, the transparency is warmed, the two are placed together film to film in an ordinary printing-frame, the back is adjusted, and everything is ready for the exposure.

The Exposure

It has already been stated that the plate is very sensitive. It follows that the exposure is very brief. The particular mixture just described does not give films nearly so sensitive as those got by some other mixtures. By some formulæ so remarkably sensitive are the films that, with a transparency of average density, the exposure may be in favourable circumstances, with the most brilliant sunshine, less than quarter of a minute. Probably about two minutes in bright sunshine will be needed for plates made as has just been described.

A quite visible image is produced, but as the plate cannot be examined during exposure—even if the operator possesses a frame allowing of the examination of an image on a ridged surface—because the damp in the air would affect the result, it is necessary to use some means of estimating the time of exposure required.

The writer in exposing has used as a rough actinometer a piece of sensitised-albumenised paper pinned to the edge of the printing-frame. A few trials with this will enable the operator to form a very fair estimate of the exposure needed. With a transparency of average density, the time taken to secure a dark-brown tint will probably be sufficient.

Development of the Image

When the weather is dry, development may begin at once, but when it is damp, it is necessary to slightly warm the plate before development begins, and it is always advisable, the worst that can result from the warming being a slight waste of time, whilst from omitting it a smudgy image is very likely to result, because the film may absorb moisture so rapidly that development will be

quite beyond control. With the plate slightly warm there need be no fear of this.

The extreme sensitiveness of the plates has already been mentioned, and as it continues after exposure to daylight, care should be taken that a safe light is used during development. If this operation be conducted by daylight, there must be no more of it than is barely sufficient to enable the operator to work. It is probably safest to work by gas or lamp light, which is quite safe, unless the plate be held within a few inches of the flame.

The plate is held in the left hand in a horizontal position, or, better, is laid on any flat surface. A small quantity of the powder is thrown on to the centre of it, and by a rapid motion of the brush is spread over the whole surface of the film. It must be kept in constant motion till the picture is fully out; a little additional powder being added to replace any dusted by the brush over the edge of the plate.

The image should begin to show before the end of a minute,—that is to say, the image in powder. It has already been explained that there is a quite visible image in the film itself. Nothing should, however, be done to hurry matters till after the end of a minute, or, if the plate has been warmed, till a little time after it has become as cold as the surrounding atmosphere.

If at the end of the time specified no image appears, or if after it has disappeared, it gains in strength but very slowly, the plate is gently *blown* upon. Some are in the habit of breathing on the plate, but this is a custom which is rather to be deprecated, as a frequent result is to make the film too damp, and to cause it to be covered all over with powder, producing impure high lights. The result of blowing is to cause a current of a mixture of the breath and surrounding air to impinge on the plate, and this should give just dampness enough to cause the image to come out, if it has not been over-exposed. After a little practice it will be found that the process lends itself better than any other to the production of certain artistic effects by local application of the powder.

Fixing the Image

The object of fixing the image is to get rid of the yellow colour left by the bichromate salt. The simplest way in which to do this is as follows:—

As soon as the image appears to be sufficiently distinct, all superfluous powder is brushed away with a clean brush, the plate is coated with plain collodion, which is allowed to set, and is washed till all “greasiness” disappears by allowing a stream of water to flow on it. It is then dipped in a saturated solution of common alum till the yellow colour is gone, is again washed, and is dried.

Some object to the slightly glazed surface given by the collodion. They prefer to see the “bloom” of the actual powder without any covering film. It is somewhat difficult to wash away the bichromate without taking with it the powder forming the image—without washing away the picture, in fact. Indeed with some processes it is impossible, without a protecting film, to wash the plate in water. In the case of plates made as just described, and in some other cases, it is quite possible, if some care be taken. It will be found best to use a glass dipping bath. This is first filled with the alum solution, and the plate is dipped into it with a steady motion and without hesitating,—just as a wet plate is dipped, in fact. It is left in the bath till all yellowness disappears, the alum solution is replaced by water, and the plate is again dipped, carefully as before. It remains a few minutes in the water, and is then taken out to be dried.

If it be desired to do without the collodion film, and if difficulty be experienced in working, just as has been described, the following method, which has been successful with all formulæ that I have tried, may be adopted:—

Methylated spirit	8 parts
Water	4 „
Sulphuric acid	1 part

The water and sulphuric acid are mixed, and when the

mixture is cool, it is added to the spirit. The whole is then flooded over the plate. If after, say five minutes, the colour has not disappeared, the liquid is flowed off the plate, and 2 parts more of water are added. If the mixture still refuses to fix, further additions of water are made, but very carefully. If there be too little water, the colour will not be removed. If there be too much, the image may go altogether. It is a little difficult sometimes to strike the right proportion at once, but once it is hit upon, there need be no further difficulty so long as the same formula and the same samples of acid and spirit are made use of.

The colour completely gone, the plate is soaked for some time in methylated spirit, to get rid of the last trace of acid, and is set on edge to dry.

As has been said, there is no end to the formulæ for the powder process. I have got the best results with that which I have just described, but this is probably simply because I have worked with it more than at any other formula. All of the following I have found to be quite workable, but I prefer to use the solutions somewhat more dilute than they are here given:—

No. 1

Dextrine	.	.	.	.	.	4 drams
Grape sugar	.	.	.	.	.	4 „
Bichromate of ammonia	.	.	.	.	.	4 „
Water	.	.	.	.	.	10 ounces

No. 2

Gum-arabic	.	.	.	.	.	7 drams
Grape sugar	.	.	.	.	.	3 „
Bichromate of potash	.	.	.	.	.	5 „
Water	.	.	.	.	.	10 ounces

No. 3

Honey	.	.	.	.	.	90 grains
Albumen	.	.	.	.	.	90 minims

Bichromate of ammonia (saturated solution)		150 minims
Water		10 ounces

No. 4

Honey		2 drams
Glucose		4 „
Albumen		3 „
Dextrine		90 grains
Bichromate of potash		4 drams
Water		10 ounces

These are taken from the *British Journal Photographic Almanac* (1887), with slight alterations, so as to make the measurements be in somewhat the same terms in the different formulæ.

Nothing particular need be observed in the mixing up of the solution but that when albumen is used it must first be thoroughly whipped into a froth, and filtered or allowed to subside, as has already been described in the chapter on albumenising paper. Sometimes a solution mixed up a week or two will work well, but there is no certainty of this, and it may be said that it is always well to coat the plates within two or three days of the mixing of the solution, and, if possible, on the same day as they are mixed. Of course it will be understood that whatever solution is used must be filtered.

Light appears to have but little action on the sensitive compound whilst it is yet in the form of solution. It keeps apparently just as well (or badly) in bright light as in darkness.

It will be noticed that in some of the formulæ just given, bichromate of ammonia is used, in others bichromate of potassium. It is commonly said that these two salts are interchangeable, and they are in most processes, but they can scarcely be said to be so in the powder process. The reason of this is that bichromate of ammonium is itself somewhat hygroscopic, whereas the corresponding potassium salt is not. To give an example of the differ-

ence in action of the two salts I may mention that, in the formula first given in this chapter the sugar may be left out altogether, and yet, in damp weather, good enough pictures can be got. If, however, in this case bichromate of potassium be substituted for bichromate of ammonium, complete failure will result.

Defects in Powder Pictures

The commonest defect is a *want of purity in the high lights*. This may be due to too short an exposure, to incomplete drying before exposure, to too damp an atmosphere during development, or to defective sensitive liquid. Only a little experience and a few trials will show which of these errors is the cause of the mistake. If the error be traced to the solution, it is due to too much sugar, glucose, or honey.

Want of brilliancy of the image is generally due to over-exposure—too large a proportion of the film being rendered non-absorbent of moisture. It may, however, be due to overheating of the film in drying, an attempt to develop in too dry an atmosphere, or to defective sensitising solution. For the first case the remedy has already been given, for the second it is evident. Concerning the last, I may say that if the solution be not old, the fault lies in an insufficiency of sugar, glucose, or honey, or whatever is used to give the mixture the necessary hygroscopic character.

Unevenness or "Smudgyness" of the Image.—This is a defect very liable to make its appearance in the first few pictures attempted by the powder process. It is commonly due to an unskilful use of the brush, to a very uneven coating of the sensitive substance, or to unequal heating of the plate during drying. It is also liable to show itself if the atmosphere is loaded with moisture, if the plate be breathed on, if the exposure has been too short, or if there be an excessive quantity of hygroscopic substance in the sensitive fluid.

The Powder Process for intensifying Negatives and for producing Reversed Negatives

The way in which the powder process may be used to intensify a negative, by coating the plate with a sensitive film on the side remote from the image, exposing the former through the latter, and developing with powder, has already been mentioned. Little further need be added, except that every care must of course be taken to avoid damaging the negative film, and that it is advisable to treat it with chrome alum before it is coated with the sensitising fluid. If it has been varnished, it is quite necessary that the varnish be removed, or the fixing fluid will spoil both the varnish and the film under it. The process lends itself peculiarly to local intensification.

The powder process is very useful for the production of reversed negatives,—that is to say, those in which right takes the place of left, and *vice versa*. Of course clear glass is used in this case. The exposure may be slightly less than for pictures, as the absolute transparency of the shadows is not essential, whilst good shadow detail and dense lights are.

The formula first given is an excellent one for the two uses just described, but it is advisable, when it is used for either of them, or when it is used for the production of any film to be viewed by transmitted light—as, for example, in the case of the reproductions of transparencies—to reduce the quantity of water and of alcohol to two-thirds of that given. A mixture so made up can be spread on plain glass that has been properly polished, as easily as colodion.

As has already been said, where negatives are to be produced, the best powder to use is the very finest quality of “levigated graphite.” The same may be used with advantage for the intensification of negatives.

CHAPTER XXX

CARBON PROCESSES—*continued*

The Single Transfer Pigment Process

THE writer, in treating the pigment carbon process, or what is commonly known simply as "the carbon process," intends to proceed as he did in describing the "silver printing process," by treating first the manner of producing a picture on materials purchased ready for use, leaving over to future chapters the descriptions of the methods of producing these materials. He believes that the beginner will make the best progress if he confines himself to as few operations as possible, because then, if he find any defect occurring, he is not troubled with doubts as to whether it is due to defective manufacture of the material, or to his method of manipulating it. Of course, I do not mean to contend that manufacturers never issue defective material; but the chances of defect are enormously smaller when material is produced on a large scale by experienced workers than when it is produced on a small scale by a beginner.

When certain effects are wanted, it is likely that the photographer may find he gets the best results by making his own sensitive film or "tissue," as it is called, or, at any rate, by sensitising ready-made but unsensitised paper. The question is very much similar to that of albumenised paper, when the photographer who works on a small scale will probably find it best to purchase ready sensitised paper, whilst the printer on a large scale will likely find it

advisable to sensitise his own paper, probably even to albumenise it.

The Tissue

It will be already understood, if the first chapters of this book have been read, that the working of the pigment process depends on the fact that gelatine containing bichromate of potash or ammonium (or any of several other salts) remains soluble in hot water for some considerable time if it be kept in the dark, but becomes quite insoluble after a shorter or longer exposure to light.

The tissue, then, is a film of gelatine containing bichromate and also a pigment consisting of some substance insoluble in water but which is retained in a very fine state of division, this film being generally supported on paper.

Practically any colour of pigment may be incorporated with the gelatine, the colour of the photograph produced depending of course on the colour of the pigment used. Certain colours are particularly suitable for photographic work, as, for example, brown, purple, black, and red (of the colour of red chalk). The two first are those generally used for portrait and landscape work, the two last generally for the reproduction of engravings, red chalk drawings, etc. The red is, however, very effective for a certain class of portraiture. Various other colours are useful for special purposes.

Sensitive tissue may be obtained from Marion and Co. and the Autotype Company in this country. It should, of course, be kept from light and in as dry a place as possible. If these precautions be attended to, it will keep for at least a week, probably for two or three. It is possible at any time to discover whether the tissue is still in good condition by taking a small piece of it, dipping it in cold water for a few minutes, then plunging it in water at about 120° Fahr. If the coloured gelatine dissolves clean away, the tissue is still in good condition. If it do not dissolve away, or if a thin insoluble film come away from the

surface of it, the tissue has become useless through long keeping.

Preparations of the Negative and Exposure of the Tissue

A negative which will give a moderately brilliant silver print full of half tone and without excessive depth of shadow is best suited for carbon printing, although methods will be afterwards described of getting vigorous prints from comparatively thin negatives and pictures not over hard from negatives that show very strong contrasts. The only preparation the negative requires is the application of a "safe edge." This is simply an edging of any opaque substance extending inwards for about an eighth of an inch and applied to the back of the negative. Bates's black varnish is the most convenient material to use, and this is very readily applied by tying a small colour brush to the



side of its stick or handle, as shown in the sketch, the stick acting as a guide, and allowing the brush to be run rapidly round the negative.

The reason for applying the safe edge is that without it the film may "frill" away from its support during the process of development. The printing may be performed in the common frames, but as it is never necessary to look at the image, the back does not need to be hinged. In the darker tissue the image is quite invisible. In the lighter colours there is a faint, visible image, by which it might be possible to judge of the exposure, but as opening the frame always means the possibility of access of damp to the film, it is best, even when printing light-coloured tissue, not to open the back. Indeed, some good authorities advise that a piece of American cloth be placed behind the tissue, so as to reduce the chance of the access of even the smallest amount of moisture. It is to be understood

from the beginning that the tissue must, throughout all operations, be kept as dry as possible.

The image not being visible, it is necessary to have recourse to an actinometer to judge of the exposure. Actinometers are of various forms, but they all depend on the use of ordinary sensitive paper, so placed that the darkening of it may be readily observed, and that the amount of light may thus be roughly gauged. They may be divided into two classes: one in which the sensitive paper is exposed to the full printing light till it turns to a certain shade, when a second piece is substituted or the strip is moved on a stage, each time this is necessary being reckoned as "one tint"; the other, in which a strip of sensitised paper is placed under a screen, having a series of gradations of density, each gradation being marked by an opaque number. With such an actinometer the portions of paper under the most transparent parts print first, as might be expected, whilst the rest take comparatively longer to show such a tint as makes the opaque number appear visible. The most transparent part is marked 1, the next 2, and so on, and the last figure visible is the one which is read. Thus, if figures 1, 2, 3, 4, 5, and 6 are visible, but 7 is not, it is said that the actinometer indicates for 6 tints.

A rough idea of the exposure necessary may be got by saying that the tissue generally issued ready sensitised is about twice as rapid as albumenised paper. This is, however, but a very rough statement. Many factors tend to alter the sensitiveness of the tissue, amongst others, long-keeping, which renders it more sensitive.

It is well to ascertain, with some degree of precision, the rapidity of the tissue before beginning to print. If a graduated actinometer be used, it is readily ascertained by placing a narrow strip of the tissue and another of the sensitised paper alongside each other under the graduated screen, so that the light acts on both at the same time. The tissue is then developed as described hereafter, when, on comparing it with the strip of sensitised paper, due allowance being made for the reduction of vigour which

the last-mentioned would undergo during toning and fixing, and for the fact that the tissue *gains* a trifle in depth in drying, a very fair estimate of the relative sensitiveness may be gained.

With all precaution the beginner can only expect to make several failures, and to gain certainty in timing exposures only by experience, as the differences of density of various negatives can only be gauged by an experienced eye, and the only way of proceeding at first is to try several different exposures till the right one is hit. Fortunately there is very considerable latitude in the exposure permissible, error being corrected during development. It is thus possible with some practice to expose with almost as much certainty as in the case of ordinary sensitised paper.

The Development

This is done by the aid of cold and hot water only. The apparatus necessary consists of several dishes either of zinc or porcelain large enough to hold quite comfortably the tissue to be developed, a "squeegee" a couple of inches longer than the breadth of the broadest print, a smooth board or sheet of zinc somewhat larger than the largest piece of tissue to be developed, and some "single transfer paper." This is white paper, coated on its surface with insoluble gelatine.

Four baths should be used, although it is possible to do with only three, by using the first for both cold and hot water; I shall assume, however, that four dishes are used, and shall number them 1, 2, 3, and 4. Nos. 1 and 2 should be large enough and deep enough to permit of the free manipulation of several sheets of paper in each.

Into dish No. 1 is poured cold water, dish No. 2 is filled with water at from 100° F. to 110°. In No. 3 is cold water, and in No. 4 a saturated solution of common alum.

Into dish No. 1 is placed a piece of single transfer paper face upwards, and after a few minutes a piece of exposed

tissue face downwards. The latter will at first curl face inwards, but after a minute or so it will begin to straighten itself out. Whenever it has become quite flat, or a little before, the two pieces of paper (the single transfer paper and the tissue) are pulled out of the water together. They are laid, transfer paper downwards, on the smooth board or sheet of zinc, and the squeegee is applied vigorously to the back of the tissue. The two pieces together are then placed aside with a couple of sheets of blotting-paper below them and another couple above. Further sheets of single transfer paper and of tissue are similarly treated till there is a pile between blotting sheets of perhaps a dozen exposed prints. If it be desired to develop only one or two prints for a trial, they should be left with a board and weight on the top for quarter of an hour or twenty minutes before the next operation begins. If a dozen or so have been squeegeed down, the first will be ready for development by the time the last is added to the pile, and the pile may be turned upside down, so that the first will be at the top.

The first print squeegeed down is now placed in the warm water. After it has been there for a few seconds, a little of the pigment will be observed to exude from between the two sheets of paper. Whenever this appearance becomes pronounced, the two are separated by the fingers at one corner, and the paper which originally supported the tissue is drawn slowly away, and is thrown on one side.

Some warm water is now at once dashed by the hand on to the face of the print. The still soluble gelatine and pigment are washed away, and gradually the image shows itself, at first dimly and buried in pigment, by degrees becoming clearer as the high lights become purer.

If the exposure has been correct, the development will occupy three or four minutes. It may be performed much more rapidly, but this is by no means desirable. Indeed, many good operators prefer to take a much longer time than that mentioned, contending that the slower the development, the more perfect the gradation of the tone. It

is at any rate inadvisable to hurry the development in any way unless the picture is over-exposed.

Development should be continued till the picture is just a shade lighter than it is finally required to be, because it gains a trifle in drying as already mentioned.

Whenever it is considered that the picture is sufficiently developed, it is placed in dish No. 3, which contains cold water.

It is quite possible, after a little practice, to have several prints in the developing bath at one time if they be not very large. The lowest one is constantly lifted to the top, and if it appear to be behind the others is treated by dashing water on its face so as to bring it up.

It may be useful to know that common albumenised paper may be used in place of either single transfer paper, or the final support used in the double transfer process. In all the older carbon processes some cement was used to fix the gelatine image to the support, and amongst them was albumen.

Common albumenised paper contains salt, as the reader well knows, but this has no bad action on the carbon film. In using the albumenised paper the operations are exactly the same as in using single transfer paper, only that the albumenised paper must be soaked in water no longer than is necessary to soften it, otherwise the albumen will be dissolved away and will not, of course, act as a cement. The albumen in the high lights is sure to be dissolved away during the development, with the result that a fine mat surface is got. In spite of the mat surface, the writer considers that almost better results are got, in the case of small work, with the ordinary albumenised papers in the market, than with the papers specially coated for single and double transfer, and the thin albumenised paper is certainly particularly well suited to the production—to be described hereafter—of the particular kind of print known as “Lambert-type.”¹

¹ The use of common albumenised paper, in the way just mentioned, was first described to me by my friend, K. Ogawa.

Fixing the Print

The object of fixing is merely, as in the case of the powder process, to get rid of any trace of the orange or yellow colour of the bichromate of potassium which may remain. The alum bath effects this object; besides this, it has the effect of completely hardening the gelatine which forms the image, thereby making it less liable to injury from dampness, etc.

The prints are allowed to remain in the alum solution till the last trace of yellow colour has disappeared. They are then washed, to get rid of the alum, and are hung up to dry. When dry they are finished.

Under and Over Exposure

It is possible, in the carbon process, to compensate considerably for errors in exposure by varying the development.

The indication of under-exposure is that the print is too light, and is wanting in details of the high lights if no attempt be made to compensate the shortness of exposure. If it be observed that the picture is developing too quickly, it should at once be placed in cold water, whilst a bath of water of a temperature of only about 95° Fahr. is prepared. And in this the development is continued. It is very difficult to compensate for any but a very small error of exposure on the under-exposed side if the error be detected only after development has begun. Very often, however, the discovery that one print has been under-exposed is an indication that a number of others suffer from the same defect. In this case a good deal may be done by beginning development at 95° Fahr., and proceeding very cautiously; although certainly the best thing to do would be to take advantage of the "continuating action of light," to be described at the end of this chapter.

Over-exposure is more readily treated. The results of it are impurity of the high lights and heaviness in the shadows. In fact, the picture generally is too dark.

In this case the temperature of the water should be raised somewhat, say to 120° Fahr., and plenty of time should be given. It is better to allow a long time to reduce the depth of the print at a moderate temperature than to try to force the development with hot water, except in certain cases. These are where the negative is rather thin, and the prints, when normally exposed, tend to give an image slightly lacking in contrast. The use of water up to 150° is admissible in such a case, but the writer prefers to keep the temperature not higher than 120° Fahr., and to add a little ammonia—enough to make the water smell strongly—to the bath.

If very hot water or warm water, with an addition of ammonia, be used to develop prints from a fairly dense negative, which have been very much over-exposed, the result will be hard prints.

The Continuing Action of Light

The curious action to which the above title has been given must never be left out of consideration in working the carbon process. By it is meant that, after the print has been taken from the frames, even if it be kept in absolute darkness, the action continues, so that it is possible, by giving a short exposure and keeping the prints for some time, to get proofs quite dark enough.

Foxlee has shown that the action does not take place in an atmosphere that is quite free from moisture, and the fact that the amount of continuing action varies with the dampness of the air makes it difficult to take advantage of the action to shorten exposures, as it is never known precisely how long keeping will be necessary to compensate for a given shortness of exposure. Advantage has, however, at times been taken of the continuing action. Abney says, "When one quarter of the exposure was given, a print hung up in the dark was found to be properly printed in twelve hours; whilst, if only one-eighth, it required sixteen hours."¹ In the writer's experience the

¹ *Instructions in Photography*, p. 282.

effects of continuing action are very much less than these, but, however great or small it be, the existence of the action as a possible disturbing element must never be lost sight of; moreover, as has already been stated, the action may be taken advantage of when the appearance of one print of a batch, on development, indicates that all have been under-exposed. The prints are simply put on one side to wait for some hours.

CHAPTER XXXI

CARBON PROCESSES—*continued*

The Double Transfer Process

THE disadvantage of the single transfer process just described is that, unless special reversed negatives are used, the prints obtained are reversed as regards right hand and left. It will at once be seen that, for certain pictures, this is fatal. On the other hand, there are some in which the reversal is of no consequence. This is the case in such objects as are "bilaterally symmetrical," which have, that is to say, the two sides precisely the same. It is also the case with many other objects which it may be desired to photograph. For example, if a manufacturer need a photograph of such a thing as a piece of furniture, it does not, in ninety-nine cases out of a hundred, matter whether the photograph represents the article exactly as it was photographed or exactly reversed.

Indeed, the writer is of opinion that the single transfer process might be used in a great many cases when it is generally considered very incorrect to use it, as, for example, in the majority of portraiture. He is well aware that in the case of most people the one side of the face is not precisely the same as the other. Nevertheless, on applying what he considered a crucial test—showing to a number of individuals photographs of others, quite familiar to them, reversed and unreversed—the result appeared to be that the reversal was unnoticed. The individuals who were shown the prints were unable to state which were

reversed, which not, unless some particular detail clearly showed it, such as the background, or a side parting of the hair. Nor was there shown any general preference for the unreversed over the reversed pictures. Indeed, there are not wanting some arguments in favour of the reversing of portraits. Very few people have seen themselves except reversed as in an ordinary mirror, and it has been stated that those who have a noticeable difference between one side of the face and the other will generally prefer the reversed to the unreversed portrait. This cannot, however, be taken as a sound argument, for pictures of individuals are not intended to be admired by the originals only ; still the writer has no hesitation in saying that, at least in the case of most portraits, there arises no evil result from reversal. The same must apply to all photographs which are of value for their pictorial effect only, as, for example, the majority of sea-scapes.

Allowing, however, for all the cases mentioned, there are still a great many in which reversal is not admissible. In the case of these it is quite necessary either to produce a reversed negative or to have recourse to the double transfer process. The production of reversed negatives is without the scope of this work, but I may say that the photographer will find it best to use the double transfer process in all cases where other than a large number of prints of the same subject are needed. Where more than a few dozen prints from one negative are wanted, it will well repay the operator to make a reversed negative.

The principle of the double transfer process is as follows:—The exposed print is squeegeed on to a surface prepared with wax or some such substance. To this surface it will adhere whilst it is wet, but not when it is dry ; as a consequence, if the print be developed on this surface, as described in the last chapter—if, afterwards, whilst it is still wet, there be applied to it a support, of paper or other material, to which it will adhere when dry, and if the whole be then allowed to dry, the print will leave the support on which it was developed, and will

remain on the second one, in which case it will no longer be reversed.

The surface on which the print is first developed is known as a temporary support. Temporary supports are of two kinds—rigid and flexible.

Rigid Supports

The form of rigid support which has found most favour is one of zinc, thick enough to be manageable and finely ground or milled on one side. An hour or two before development is to take place each sheet of zinc is waxed by carefully rubbing over it with a piece of soft flannel a mixture composed as follows:—

Bee's-wax	3 drams
Yellow resin	6 „
Oil of Turpentine	1 pint

It is also necessary to get ready the final support on to which the print is to be transferred after development, fixing, etc., are complete. Until quite lately the final support generally consisted of paper or other material coated on one side with gelatine rendered semi-insoluble by the action of chrome alum. To use it, the support was soaked in water of such a temperature as would render the gelatine slimy. The only objection to this paper was that the gelatine tended, by keeping, to become more and more insoluble, so that it was always a question of experiment to discover what temperature of water was needed to bring the surface into the right condition.

Recently the Autotype Company have been issuing a final support, which is simply coated with soluble gelatine. This support has only to be soaked in a weak solution of common alum for a little time before it is needed, when it is ready for use.

It is best to have the final supports in the alum bath before development is begun, so that no further thought need be given to them till they are needed. The bath used is simply a 2 per cent solution of common alum.

Into this are placed as many pieces of temporary support as there are prints to develop, care being taken that no air bubbles are allowed to stick to the surface. The size of the pieces of final support should be a little greater than that of the prints.

All being now ready for development, a sheet of zinc is placed in the cold water bath face upwards; an exposed piece of tissue is placed above, is left till it has curled up and straightened out again, and is then squeegeed on to the zinc support. After this all processes are the same as in the single transfer process up to that stage when the print (in this case on the zinc) comes to be dried. It may now be dried or not as may be most convenient. If it be desired to proceed with operations it is not dried, but a piece of the final support is brought down on to it, is squeegeed down, and the two are dried together. When they are dry, they will probably separate of their own accord. If they do not, they may readily be caused to separate by inserting the blade of a pen-knife under one corner of the final support. If the print has been allowed to dry on the "temporary support," the whole must be thoroughly soaked to wet it again before the final support is applied. As has already been said, ordinary albumenised paper may be used without any special preparation as the final support.

Flexible Supports

The "flexible support," which was invented by Sawyer in 1874, consists of paper coated first with insoluble gelatine, afterwards with a mixture of various lacs, so that it is impervious to water, imperviability being the condition necessary to secure the adhesion of the exposed tissue without the use of any special cement.

The chief advantages of the flexible support are its lightness and manageability, the facts that when it is used a number of prints may be manipulated at the same time if desired, and that there appears to be more perfect adhesion between the print and the support when the latter is flexible than when it is rigid.

The flexible support is waxed a few hours before it is needed for use, just as described for the rigid support. It can easily be cut to any size, and is most easily managed when a little larger each way than the print.

All the flexible supports that are needed for development are placed face upwards in the first dish—that containing cold water—and the exposed prints are placed in the bath one at a time, left there till they are flexible, then squeegeed, one at a time, on to the supports, as already described for the single transfer process, and when rigid supports are used. The operations are further precisely the same as for single transfer till the point where the prints have been fixed in alum and washed. After this, each is brought into contact with a piece of final support, as already described for the rigid support. The two are dried together, when they may very readily be separated.

The flexible supports may be used an indefinite number of times, all that is necessary being to wax each sheet before it is used again, although even this precaution is scarcely needed after they have been used a few times.

CHAPTER XXXII

CARBON PROCESSES—*continued*

Lambert-type—Transparencies, Lantern Slides, Opals, etc., in Carbon

THE carbon process had been published for some years, and had been worked extensively by a few, and in a more or less tentative manner by a number of photographers, when great excitement was caused by the introduction of an improved process by Lambert which, it was thought at the time, would certainly revolutionise the carbon process.

The prints got by Lambert's process—and entitled Lambert-types—showed a marvellous brilliancy of colour and surface, and a depth of shadow detail not seen before.

The brilliant surface was due to the fact that the prints were developed on collodionised glass, and that, being stripped from this when dry, they showed the polished surface of an enamelled print. The enamel is strongly objected to by many, but it appears to render the carbon process much better suited to small work than it otherwise would be.

There can be little doubt that the great excitement produced by the advent of the Lambert-type was, in part at least, due to the brilliant tints which Lambert got by the use of the lake colours; but, alas! it was soon found that these colours were evanescent, and that pictures in them faded, and they had consequently to be given up. It is an unfortunate fact, that it appears to be impossible to get permanent colours of as great richness as some which

are not permanent. There is, for example, a certain "bloom" in a silver print that has never, in the writer's opinion, been approached in a print in *permanent* pigment.

This is, however, beside the mark. What we have here to concern ourselves with is the practical working of that part of Lambert's process which is available with permanent pigments,—namely, the development on collodionised glass.

Various attempts had been made before Lambert brought out his process to develop on collodionised glass, but all failed more or less, the image either breaking up during development or, when dry, refusing to leave the glass. The improvement introduced by Lambert consisted in the waxing of the glass before it was collodionised.

Glass plates a little larger than the prints to be developed are thoroughly cleaned, and on to each is poured a little of a solution of

100 grains pure wax.
20 ounces pure benzine.

Glass of any kind will do, but opal glass is to be preferred, as development can so much more readily be judged of with it than when transparent glass is used. The glass known as "smoothed"—that is to say, glass that has had one side "depolished"—should not be used, as the "smoothed" side will not give the polish peculiar to the "Lambert-type," and the "smoothing" increases the price of the glass very considerably.

The wax solution is rubbed vigorously over the plate by the aid of a piece of flannel, and what remains is polished with a second piece of flannel or of "papier Joseph," only a little of the wax being allowed to remain. The glass may now be considered ready for use, but the writer has found that there is far more certainty of clean removal of the print if some powdered talc is rubbed on the surface, and the polishing is continued till the glass appears quite clean.

The required number of plates having been waxed, one is coated on the waxed side with plain collodion. The collodion is allowed to set fairly stiff, and the film is

washed with water till the apparent greasiness which it shows at first disappears. This indicates that the alcohol and ether have been washed out of the film.

The plate is now laid film side upwards in a dish of clean cold water. An exposed print is placed face downwards in the water till it has curled up and again straightened itself out. The sheet of glass and the piece of tissue are taken out of the water together, a piece of thin sheet rubber¹ a trifle larger than the print is placed on the back of it, and the back of the rubber sheet is steadily and gently squeegeed over to bring the tissue into close contact with the collodion film.

Between the time when the tissue is squeegeed down and that when development begins, there should elapse from quarter to half an hour, during which time the glass plate and tissue should be under some pressure between sheets of blotting-paper.

Development is performed in the usual way, but must on no account be hurried. Indeed, it is best to let it proceed entirely unaided by leaving the plate, after the paper of the tissue has been stripped from it, lying either in a horizontal position face downwards, or in a vertical position in water of a temperature of about 105° Fahr., till development is so far complete that only a slight rinse with warm water is needed to finish it.

If only a few prints have been printed, they may readily be developed by having a basin of warm water for each. The paper being stripped from the plate, warm water is dashed on to the pigment remaining on the latter to remove air bubbles, then the plate is allowed to rest face downwards on its four corners in the basin. If a number of prints have to be developed on collodionised glass at one time, any of the plate-washers in which the plates stand vertically in grooves may be used, the box

¹ It is commonly recommended to place a sheet of rubber at the back of a print before squeegeeing it, whatever the support is, and certainly the precaution is a wise one; but the rubber is much more necessary when development is to be performed on collodionised glass than in other cases.

being simply filled with water at a temperature of about 105° Fahr.

The prints being developed, fixed, and washed, the final support is applied to them, as described already, and they are placed on one side to dry. When dry the prints strip from the glass with a full enamel gloss. They must be mounted in the way described for all prints with the surface commonly denominated "enamel."

Transparencies in Carbon

The very easiest method of carbon printing is that whereby such transparencies as may be hung in windows, etc., are made. Indeed, the whole process consists in developing a piece of exposed tissue on a sheet of clear glass. No double transfer is ever needed, as the transparency may be hung with either side to the light.

A special tissue is sold by tissue makers for the production of transparencies, the peculiar feature being a larger quantity of pigment than is incorporated in the ordinary tissue. To ensure success this special tissue should be used, but it is quite possible with vigorous negatives and tissue of the ordinary make to produce good transparencies simply by giving a considerably longer exposure than that needed for a print.

The very simple method above indicated will result in the production of transparencies that are all that can be desired for window decoration and such-like purposes, but when it is needed to produce a transparency of the extremest delicacy and of the highest degree of definition, as for a lantern slide, or for the purpose of reproducing negatives, or when it is desired to reproduce negatives from such transparencies, a slightly more elaborate process gives the best results.

Plates of glass, which for all the purposes mentioned, but especially for the production of lantern slides, should be of good quality and quite flat, are prepared in the following manner:—

A mixture of 1 ounce of gelatine in 18 ounces of water

is made by soaking the gelatine (preferably of moderately hard quality) in 18 ounces of cold water till the former has thoroughly swelled up, then warming the water till the gelatine is melted; 20 grains of bichromate of potassium are dissolved in 2 ounces of water, and the solution is added to the warm gelatine and water.

The glass plates are coated with the thinnest possible film of this mixture, the manipulation being exactly the same as that of coating a plate with collodion, and the film is allowed to dry in the sun or in the strongest available light.

For transparencies of great delicacy, such as those under consideration, it is quite necessary to use a tissue specially prepared for transparencies,—heavily laden, that is to say, with colour in a very fine state of division. The exposure needed is at least 50 per cent greater than that for prints.

A piece of the exposed tissue is coated with plain collodion by slightly turning up the edges, flowing a considerable quantity of collodion on to the surface, and pouring away the excess.

The collodion film is allowed to dry, when one of the prepared glass plates is placed film upwards in a dish of cold water. The exposed and collodionised tissue is brought into contact with the glass plate in the usual way, and the two are placed under pressure between sheets of blotting-paper, where they must remain for at least half an hour. Development then goes on in the usual manner, the effect being, of course, judged of by looking *through*, not *at* the image.

To reproduce negatives a positive is first made as just directed, but receives a somewhat fuller exposure than would be considered desirable for pictorial effect, so that no portion remains quite clear after development. From this positive a negative is made in precisely the same way as was the positive.

Opalotypes

The above somewhat barbarous name is generally given to any positive having opal glass for a support. Such

pictures are very effective, and are readily produced by the carbon process. All, indeed, that is necessary, if reversal be not considered objectionable, is to squeegee a piece of exposed tissue on to the "de-polished" surface of a piece of "smoothed" opal glass and to develop. If reversal be considered objectionable, the print must be developed on the flexible support and transferred to the opal surface, or a reversed negative must be made to begin with.

The carbon process is applicable to the production of images on many surfaces besides those mentioned. For example, ivory, wood, drawing-paper, and canvas; but for particulars with regard to such applications the reader is referred to special works on the subject.

CHAPTER XXXIII.

CARBON PROCESSES—*continued*

Sensitising Tissue

SOME good authorities on carbon printing hold that as good results are not to be had with tissue sensitised after it has been otherwise completed than with that sensitised when it is made,—that is to say, that the results got when the bichromate is added to the tissue are not so good as those got when it is added to the liquid pigmented gelatine used for coating the paper.

However this may be, there can be no doubt that the difference is very slight. Moreover, as a great many photographers—perhaps the majority—are not in a position either to make their own tissue or to supply themselves with it whenever they require it, the sensitising of tissue is a thing that has to come under consideration.

Tissue is purchased either in long bands or in pieces cut to certain sizes and packed flat. It is most easily handled when it is in the last-mentioned form, as when once it has been rolled tightly up, it is far from easy to unroll it without cracking the surface.

Various chromic acid salts act as sensitisers to carbon tissue, but of these there are only three in common use. These three are bichromate of potassium, bichromate of ammonium, and the double chromate of ammonium and potassium.

The first is the most commonly used, although it is quite generally known that tissue sensitised with it does

not keep so well as tissue sensitised with either of the other two salts, and this especially if the commercial—and frequently unduly acid—bichromate of potassium is used.

The objection to the bichromate of ammonium is the comparatively high price.

The double chromate of ammonium and potassium was first recommended, some years ago, by Eder, who has made a most elaborate investigation of the action of the chromium salts. It was first recommended as a substitute for bichromate of potassium, because it gives a tissue in every way equal to that sensitised with the latter salt, and at the same time much less liable to spontaneous insolubility—of much better keeping qualities, in other words. It is the writer's opinion that the double salt may, with advantage, replace bichromate of potassium, not only in the carbon process, but in all analogous processes. The double chromate of potassium and ammonium is not a salt readily obtainable commercially—indeed I do not know that it can be so obtained at all—and it is a little troublesome to make in the solid form. It is, however, fortunately exceedingly easy to make it in solution. A solution of bichromate of potassium of moderate strength is of a bright red colour. If liquid ammonia be added to this solution drop by drop, very little change of colour will be noticed at first, and, moreover, it will be found that the ammonia does not communicate any of its peculiar smell to the liquid. It enters into combination to form a new salt. If, however, the addition be continued, the colour of the solution will change, almost suddenly, from red to light yellow, and, if only a drop more of the ammonia be added, the solution will have an ammoniacal smell. At the moment of the change of colour, the bichromate of ammonia has been completely changed into the double chromate of potassium and ammonium.

The sensitising bath commonly recommended is merely a solution of bichromate of potassium, and the only thing that is necessary to convert it into a bath of the double

salt is to add ammonia till the change in colour just described takes place, and, as there is no harm in having a little excess of ammonia, the operation is a particularly simple one.

The process of sensitising consists merely in soaking the tissue in this solution.

The strength of the solution may vary within moderate limits. Variations in strength produce considerable variations in result; but this matter will be treated hereafter. Meantime we shall merely consider the use of a bath of what may be considered average strength; and I shall give practical details of the manipulations.

The following bath is made up :—

Bichromate of potassium	.	.	.	3 ounces
Water	.	.	.	80 „

The bichromate does not dissolve in the water very readily unless it be in the form of a very fine powder. The best way in which to effect solution is to place the bichromate in a muslin bag, to suspend this bag in a jug large enough to hold the water, to pour the water hot into the jug, and to let the whole stand till the bichromate is quite melted.

The solution may be used without further addition, at any rate if the bichromate is known to be chemically pure. It is almost necessary, in the case of most commercial samples of the salt, and it is always advisable to add at least a little ammonia—say a quarter of an ounce to the amount given above—to neutralise any free acid that there may be in the solution, but, as has already been indicated, the writer considers it advisable to add a great deal more, to continue the addition, in fact, till the change in colour above indicated takes place, and till the solution smells quite distinctly of ammonia.

Sensitising, as already stated, consists simply in immersing the tissue in the bichromate bath; but before sensitising is begun, it is necessary to take into consideration how the tissue is to be dried, this being a most important matter.

Various points must be particularly attended to. Thus it is essential that the drying be fairly rapid, otherwise the surface of the tissue will become insoluble even in warm water, and it will be found impossible to get pure whites in the prints.

On the other hand, drying may not be accelerated by a rise of temperature other than very moderate, otherwise the gelatine of the tissue, which is generally a somewhat soft variety, will certainly be melted, the result being of course that the tissue is rendered useless.

Where work is carried on on a very large scale a special room may be provided for the drying of tissue; but probably if work be carried on on a scale sufficiently large to justify this, it will be found of advantage to make the tissue from the beginning. The nature of room best suited for drying tissue, if a special room be constructed, will be treated of in the next chapter.

The object is to dry the tissue quickly, at a temperature never exceeding, say, 70° Fahr. The tissue should never take more than about twelve hours in drying; and it is an advantage if it can be dried within about eight hours.

No place is better for drying tissue than an ordinary room with an open fireplace. If drying is to be performed during the daytime, of course the room must be specially darkened—not like a dark room for development, but as a room has to be darkened when ordinary sensitised paper is to be quite freely worked. It will generally, however, be found convenient to hang the paper up at night, and to remove it early in the morning. The best way in which to work is to light the fire two or three hours before sensitising begins, to let it blaze up for a couple of hours, so as to thoroughly *dry* the room—this being an essential to rapid drying of the tissue—to let the fire get low when sensitising begins, and to place on it a large “gathering coal,” which will keep up a low fire—enough to stimulate ventilation—during the whole or the greater part of the night. Any of various “slow-combustion stoves” that can be depended on to burn without attention may be used.

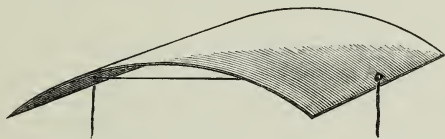
Another thing that has to be considered before we

begin sensitising is to provide means for holding the tissue during the time of drying. It is a common practice to hang up the sheets by American clips, but this system has the drawback that some of the sensitising fluid is liable to gravitate to the lower edge of the sheet; the result being that that portion may be more sensitive than the rest, and that printing may not be equal.

The thing to be especially avoided in sensitising and drying is any unequal distribution of the sensitising fluid; and the thing to be specially aimed at in drying is an equal and rapid action.

Of the various methods of drying recommended by different people I know of none better than that advised by the Autotype Company.

Pieces of cardboard rather larger than the sheets of tissue to be dried are bent into the form of a bow by



cutting a notch in the middle of each end and a piece of string stretched across.

When all the provisions described as necessary for drying have been made the process of sensitising which I now describe may begin. First, however, I may say that if the temperature of the bath is above 60° Fahr., it should be cooled to say 50° by the aid of ice.

In immersing the sheets of tissue in the sensitising bath, the great thing to be avoided is the adherence of air bubbles to either back or front. There are various ways of avoiding this. The following is the way in which the writer manages :—

The tissue is placed face downwards in the bath—an ordinary stoneware dish a little larger each way than the tissue to be sensitised,—the back of the tissue is brushed with a camel's-hair brush to remove any air bells that

may adhere. The tissue is then turned face upwards without removing it from the bath, and the operation of brushing is repeated, this time on the face. The tissue is then once more reversed.

Whilst another sheet is being immersed, the first may be left to soak, or, indeed, two or three may be in the bath at one time, but the undermost should be lifted out after it has been soaking for about five minutes. The sheet of tissue, as it is removed from the sensitising bath, is laid face downwards on a clean plate of glass, and the squeegee is passed lightly over the back of it to remove as much of the solution as is thus removable from both the back and the face. It is then laid face upwards on one of the cardboard bows above described, and is laid in what is considered the best position for drying.

One thing essential in the drying room is that it be free from any gas fumes, as such would have the effect of rendering the tissue insoluble.

The tissue when sensitised is kept in a dry—and of course dark—place between boards, with a weight on the top. Enough may be sensitised at one time to serve for a week or ten days. Some consider that the tissue is not in its best condition for working till it has been kept for about a couple of days, it having a tendency, when quite new, to give harsh lights. It must be borne in mind that it will get somewhat more sensitive the longer it is kept. It is always possible to get good results, however, so long as the film is completely soluble in warm water.

Strong and Weak Sensitising Baths—To Print from Over-Thin and Over-Dense Negatives

The strength of bath given above, about 4 per cent, may be taken as a good one for general work; but there may be times when it is of advantage to use a bath either stronger or weaker than that mentioned.

The bath may be varied between 1 per cent and 8 per cent, although it is seldom used weaker than 2 per cent or stronger than 6 per cent.

In general terms, the following are the results of the use of a very weak and a very strong bath :—

A weak bath gives a slow tissue—one that requires a long exposure—which keeps well, and tends to give pictures of great vigour.

A strong bath gives a very rapid tissue which, however, will not keep very well, and which gives very soft pictures.

It is advisable to increase somewhat, say up to 5 per cent, the strength of the bath in very cold weather.

From a consideration of what has been said, it will readily be inferred that tissue sensitised on a weak bath is most suitable for obtaining prints from a thin negative, a comparatively long exposure being given, whilst the best result will be obtained from a negative of density above the average by using a strong bath and giving a comparatively short exposure.

Here let me point out that by a “negative of density above the average,” I do not mean a negative hard from under-exposure,—from such a negative it is not possible to get a good print by any process. I assume a negative having all the detail needed, in gradation *proportionately* correct, but in which there is too great a contrast between the extremes of gradation.

The following is the way in which the best result may be got from a thin negative :—A “transparency tissue” is used ; a weak bath, say one containing 2 per cent of bichromate, is employed ; the print is made in a moderate light ; and the exposure is continued to such an extent that it will be only with some difficulty that the high lights can be brought up to a state of purity. Development is then patiently performed at a somewhat high temperature, a little ammonia being added if necessary, or the clearing of the lights being even helped by very gentle rubbing with a pad of cotton-wool.

To make the best of a very dense negative, the tissue is sensitised in a bath as strong as, say, 6 per cent. Printing is performed in the brightest light possible—an exposure as short as will serve being given—and development being carried out at as low a temperature as possible.

To Intensify Prints

It may be considered desirable to print from a negative which is so thin that even, with the precautions already mentioned, a vigorous print cannot be got. In this case—the best being made of the print possible—it is further intensified whilst it is still on the temporary support.

If it be borne in mind that the image consists of a film of varying thickness of gelatine—the deepest shadows being represented by the thickest portion, the high lights by complete or all but complete absence of gelatine—it will readily be understood that any substance which will uniformly stain the gelatine to a desirable colour will intensify the image.

A solution of permanganate of potash is one of the most commonly used agents. A little permanganate is dissolved in water so that a dark solution is made. This is flowed over the image till the required intensity is reached, more permanganate being added to the solution if it be considered necessary. Finally the image is washed.

Another method, out of many which may be adopted, is to make up a slightly acid solution of pyrogalllic acid—say, to each ounce of water 4 grains of pyrogalllic acid, $\frac{1}{4}$ grain of citric acid—and just before and during application to add to this a drop or two at a time of a solution of silver nitrate, which may be of a strength of about 40 grains to the ounce.

Probably the latter method will be found to be the best for small work on glass, such as lantern slides, small transparencies, or reproduced negative work; the former for comparatively large work.

It might be supposed that the only thing requisite to obtain a vigorous print from ever so thin a negative was a tissue with a sufficient quantity of contained pigment; but it must be borne in mind that one effect of increased pigment is to prevent the light from penetrating as far as it otherwise would. The result of this is that the increase of brilliancy obtainable by mere increase of pigment in the tissue is, beyond a certain point, very slight.

CHAPTER XXXIV

CARBON PROCESSES—*continued*

The Manufacture of Tissue

IT has already been stated that many good authorities consider that better results are to be had when the bichromate is compounded with the gelatine before the latter is spread on the paper. Certainly where ready sensitised tissue is to be purchased it is to be preferred, and it *may* even in some few cases be advisable to make the tissue from the beginning rather than to purchase it; nor is it so remarkably difficult to do so as might at first sight be imagined.

The first thing is to select a suitable paper. As the paper on which the sensitive compound is to be spread is in no case to form the final support, it is not necessary that any care be taken that the paper is not affected by light—as most or all papers are more or less—but merely that it be of uniform texture, tough when wet, so that it will stand rough handling, and not tending greatly when moistened to expand more in one direction than in another, otherwise an appreciable amount of distortion may supervene. The writer has found common cartridge-paper quite suitable.

The most important thing of all is the selection of a suitable gelatine. The gelatine must be of a high degree of purity, and must be soluble. It must at the same time be capable of giving a jelly of a good consistency. Many gelatines have been artificially hardened with alum, and are utterly unsuitable for carbon work; others are of a “gluey” consistency, and are also unsuitable. A gelatine

that is in every way particularly well suited to carbon work is that known as "Nelson's opaque." It possesses in a high degree all the desirable qualities just enumerated. The only objection that there is to its use is that the price is so high, even when it is purchased in large quantities, as to be almost prohibitive for work on a large scale. It is probable, however, that, at first at any rate, the photographer will find it pays him well to buy an expensive gelatine, the quality of which is known to be particularly suited to his work.

Other gelatines that have been recommended by experienced workers are "Nelson's flake gelatine," "Nelson's amber gelatine," and the softer of the two "Winterthur" photographic gelatines.

In cold weather any one of these gelatines may be used alone, but the resulting tissue will be found to be too soluble for convenient working in weather that is even moderately warm. To prevent this extreme solubility a certain quantity of hard gelatine is added to the soft, special care being taken to avoid those gelatines that are artificially hardened with alum. The gelatines that are found suitable for emulsion work are all good for the purpose that we are now considering—for example, Coignet's "gold label gelatine," or Heindrich's emulsion gelatine. Of the whole quantity of gelatine used about 20 per cent may be hard gelatine, except for cold weather work. A tissue known as "hot weather tissue" is sometimes made by using a far larger proportion of hard gelatine, and it is useful in cases where it is absolutely necessary to work at a very high temperature, but it is certainly not to be recommended for general use, as the difficulties of working are very greatly increased by the comparative insolubility of the gelatine.

The following formula is due to Adolph Ott, at one time chemist to Messrs. Braun and Co., Dornach, one of the largest workers of the carbon process in the world. It has given successful results in the hands of the writer:—

Gelatine	.	.	.	.	.	.	100 parts
Sugar candy	.	.	.	.	.	.	25 „

Glycerine (when necessary)	5 parts
Potassium bichromate (dissolved in 50 parts of water)	5 „
Water	300 to 400 „
Colouring matter	2 to 5 „

The above is the formula exactly as given by Ott. The following is the modification used by the writer and the exact manner of mixing the “jelly” :—

Nelson's opaque gelatine	$\frac{1}{2}$ pound
Coignet's gold label gelatine	2 ounces
White loaf sugar	3 „
Glycerine (none for any climate the writer has had any experience of, and a thing to be avoided if possible).	
Potassium bichromate (dissolved in 5 ounces of water and converted into double chromate of potassium and ammonium by adding liquid ammonia till the solution smells distinctly of it)	$\frac{1}{2}$ ounce
Water	2 pints
Colouring matter, <i>quantum suff.</i> , as to be hereafter described.	

As to the colouring matter that may be used there is almost endless variety. For all common work, however, lamp black in some form is used as the body of the colour. Any form of lamp black—or, in fact, almost any form of carbon in a very fine state of division—may be used, as, for example, “ivory black.” It is probable that, for work on a small scale at least, there is nothing so good as “Chinese ink.” It is with this that all the writer's experiments have been made. “Chinese ink” is merely a very fine quality of lamp black suspended in a sort of gelatine or in a gum, and even the inferior varieties which can be bought very cheaply are good enough for all kinds of carbon work, except such as the making of lantern slides. These being subject to great magnification, it is advisable, if they are to be made by the carbon process, to use a fairly high quality of “Chinese ink.”

A quantity of the ink is broken into fragments with a hammer—not a very easy thing, for the ink is very hard—and is placed in a cup and left covered with cold water for twenty-four hours. Any time after this the ink can easily be melted by the application of heat, forming a thick black paste.

When it is wanted to mix up the jelly, the gelatine is covered with the water, and is allowed to soak for an hour or two. Heat is then applied to melt it, and the sugar is added. This latter is very readily melted by a little stirring. Next comes the pigment. The Chinese ink paste having been melted by heat, is added little by little to the gelatine with much stirring. The colour is tested from time to time in the following way:—A small strip of thinnish white paper—common writing paper, for example—is floated for a moment on the surface of the jelly, and is then removed. It is held by one end till all the jelly that will run off of itself has run off, and it is then examined by looking through it at a lamp. The addition of the pigment should be continued till the little bit of sample tissue that has been made appears quite opaque. For “transparency tissue” the addition should be continued till there is about 50 per cent more pigment in the jelly than is necessary to produce opacity.

If a plain engraving black is needed the addition of further pigment is not needed. It is, however, a thing that should be mentioned here that some of the finer qualities of Chinese ink—probably on account of the extreme fineness of division of the colouring matter—do not give a gray tint when in very thin layers, but a slightly brownish tint, so that the prints made from such, even without the addition of further colouring matter, would be described rather as dark brown than as black.

But for general use it is considered desirable to add some warm red colouring matter to the jelly. This may be alizarine, vandyke brown, or carmine. In any case the colouring matter is added till the desired tint is got, and this is judged by smearing a little of the jelly very thinly on a piece of white paper, when the colour is very easily judged of.

If it be wished to make insensitive tissue, to be after-

wards sensitised as described in the last chapter, the jelly is ready, but for the straining to be described immediately. If ready sensitised tissue is needed, the bichromate (or more strictly speaking, double chromate) solution is added. After this it is only necessary to strain the whole mixture through a piece of fine calico, when it is ready for use.

This may be a good place in which to state that all chromatised solutions and compounds are practically insensitive to light whilst they are wet, so that all the work described above, and even the coating of the tissue, may go on in any moderately bright light.

This constitutes what is called "plain jelly."

The gelatine is allowed to soak in the water for an hour or two, then heat is applied to melt it. It is then kept in constant motion by the aid of an egg beater or small churn, whilst the other ingredients are added.

Coating the Paper with Sensitive Compound

There are various methods of coating paper with sensitive compound. When it is coated in large quantities, it is drawn in a continuous band under a roller which is put over a trough containing the compound. The trough is adjustable vertically so as to cause the paper just to touch the liquid. The continuous band of paper coming vertically coated from the trough is carried over a second roller at the top of the machine, the back of the paper touching the roller this time. Before the paper has reached the top of the vertical run the gelatine has set as the motion of the paper is very slow. After it passes the second roller, it may either be hung in festoons, the back only touching the supports, or may be cut in lengths and hung vertically in lengths.

It will be seen that when the bichromate is incorporated with the gelatine, whilst the latter is also in solution, there is no possibility that it can run to the lower part of the sheet as when tissue is sensitised with an aqueous solution of bichromate. There is, therefore, no objection to hanging the tissue in a vertical plane to dry.

Of course none but those who work on a very large scale will make use of a machine. There is, however, an easy way of coating lengths of 6 or 8 feet by hand, which gives very good results. It must be borne in mind in this connection that absolute uniformity of coating is by no means quite necessary with tissue. So long as there is a certain minimum of thickness, the only evil effect of too much material on certain spots is that such parts take longer than the rest of the surface to dry, and that, if this drying be very greatly prolonged, extra sensitiveness, or even insolubility of the part will ensue, and of course consequent unevenness of result.

The paper to be coated is cut into such lengths that if the operator stands on the ground or on a low stool holding one end of a piece of paper as high as he can, the other will be an inch or two off the ground. A dish which is an inch or two longer than the breadth of the band of paper is filled to a depth of at least half an inch with the sensitive compound in a liquid state. The paper is rolled up into a roll. The roll is laid on the liquid sensitive compound. The moment that it touches it the free end is lifted upwards, so that the roll slowly unwinds itself, always touching the liquid. By this means a surface which is almost or quite even will be obtained. The more rapidly the paper is moved the thicker will be the coating; but with a jelly so thick as that given, a sufficient coating will probably result from moving the paper very slowly. It will generally be found an advantage to have a wooden roller about an inch thick within the roll, to give weight enough to ensure that the surface will remain in contact with the liquid. The roller is, of course, left floating on the liquid at the end of the coating of each strip of paper. It must be quickly removed, washed in very hot water, and dried with a cloth.

The second method to be described is due to Bolas. In it two pieces of paper in contact, which may be of any length, are drawn right *through* the sensitive fluid. The result is that the pieces of paper which are back to back are coated each on one surface only, whilst the jelly flows

between the two pieces only to a very small distance, in fact, just far enough to cement them together, so that in drying, the edges being fixed together, the tendency of the coated surface to curl outwards is counteracted.

It is necessary for coating by this method to have a dish into which it is possible to depress a roller or thick glass rod. The two pieces of paper are then immersed by pressing them by means of the roller under the surface of the fluid at a few inches' distance from the end of the pieces of paper. They are then drawn through the liquid, being all the time kept quite tight. On a small scale this may be done by having one operator at each end of the paper, one pulling it through, the other keeping a slight strain on it.

The requirements for drying tissue coated as described are the same as those for drying tissue sensitised in a bichromate solution; but as already explained, it may be hung vertically during drying.

If work be done on a very large scale, it may be considered advisable to fit a special room for drying. In such a case the condition to be most fully observed is that there are very large openings for the inlet and outlet of air. These can indeed scarcely be too large. Of course it is necessary so to arrange the openings for ventilation that light does not enter by them. It may be said that there should be at least 1 square foot of area of inlet and outlet for every 1000 cubic feet of capacity of room.

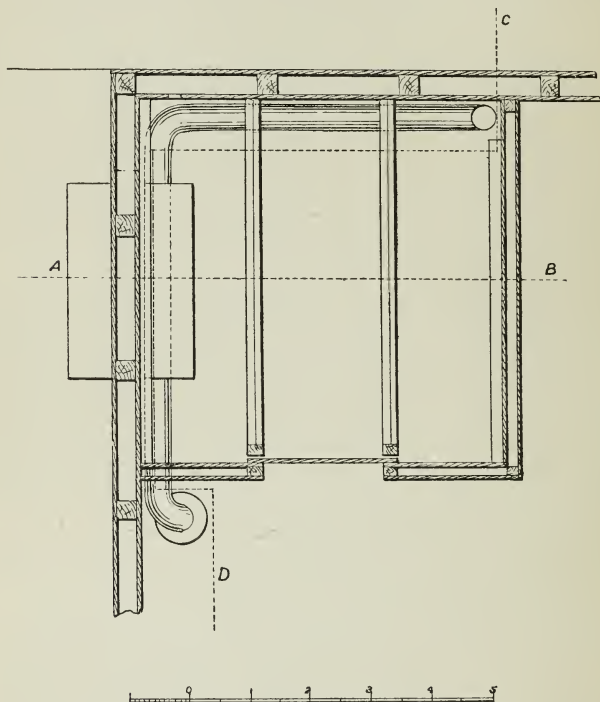
The room may be of such size that the lengths of tissue may be hung at least 2 or 3 feet apart.

Ample ventilation being provided, the room may be warmed by hot-water pipes round the floor. The air inlets should be so arranged that the incoming air impinges on these pipes and is thus warmed. If there be as much area of air inlet and outlet as is indicated, the hot-water pipes will cause a rapid current of air without raising the temperature much, and this is what is needed.

Above all things it is necessary in the drying room to avoid the presence of the products of combustion or similar gases. Thus it is better if possible to work in the room by daylight admitted through yellow blinds, rather than by

gas or lamp light. Not because the last-mentioned form of light is dangerous through its actinism, but because the products of combustion which it gives off are dangerous, being liable to render the tissue film insoluble.

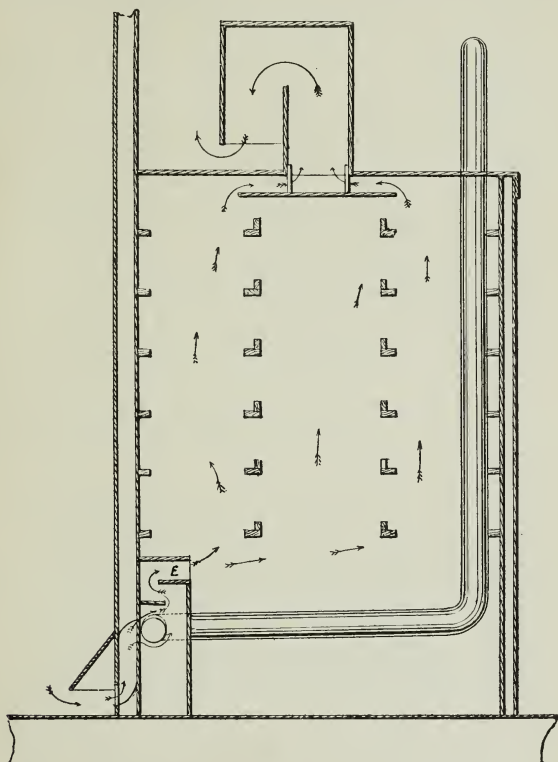
I think it worth while to reproduce here a set of drawings and a part of the description of a drying room given by me in the *Photographic Times* for March 23, 1888. This



room was, it is true, designed for the drying of plates, but it has since been put to the purpose of drying tissue, and has given the most complete satisfaction.

“I have frequently stated my conviction that the first and chief essential for a good drying arrangement is large size of air passages—both inlet and outlet. In speaking of ventilation, I speak on a subject of which I have had con-

siderable experience outside of photographic work, and I have no hesitation in saying that ninety-nine out of a hundred failures in ventilation of buildings of all kinds are due to insufficient size of the air passages. I have frequently seen a large room ventilated—or rather the attempt made



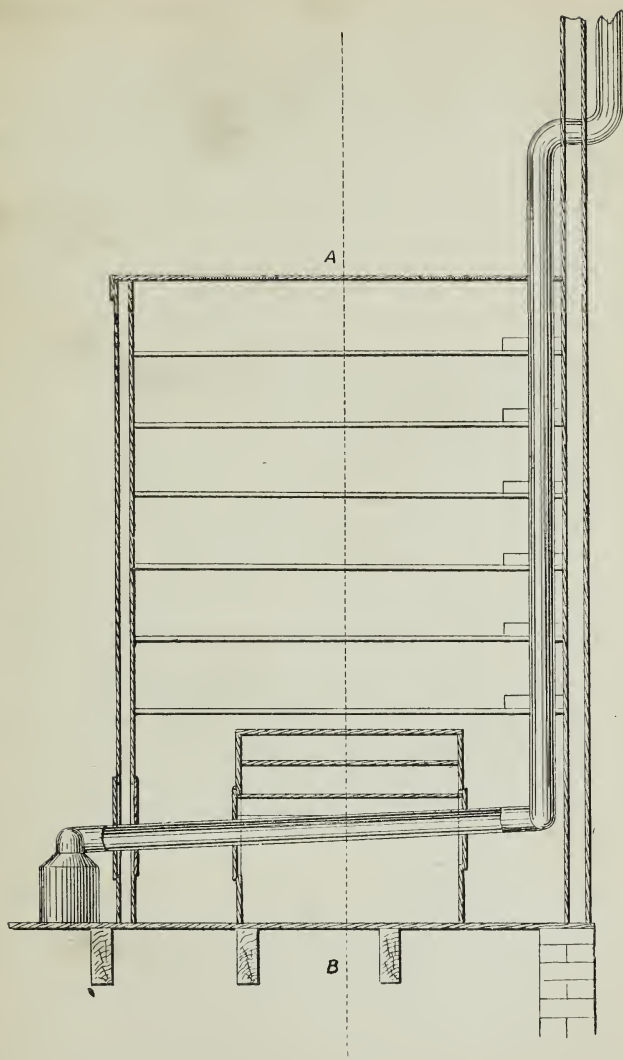
to ventilate a large room—by a single inlet aperture measuring, perhaps, 8×4 inches, or, indeed, sometimes even smaller. Now, with any velocity of current to be reasonably expected through such an opening, it will take several hours to bring about a single change of air. I am writing now of what I have seen in England. The same

defect is to be found in most arrangements for drying plates. I remember seeing a large plate factory in England, in which the ventilation of a very large drying room was supposed to be effected through a long tube 3 inches in diameter! It is true that a fan was used to exhaust through this tube, but had the fan been capable of producing an absolute vacuum the size of tube would have been very greatly too small. In the particular case in question, probably the greater part of the ventilation that there was took place through the walls of the room. *A very large quantity of air will pass through even brick walls* when there is a considerable difference of temperature outside and inside of a room, so as to cause a slight difference of pressure.

“For real ventilation, however, I insist first on large cross-section of inlet and outlet apertures, and I may add to that the warming of the air *as it enters the room*. With a given expenditure of heat, tissue will be more quickly dried, if the heat is expended in warming the incoming air, than if it is allowed to warm the whole room by radiation merely. This is not a statement made at random, there are definite reasons for making it, which, however, I cannot here enter into.

“The drawings that I send are to scale, and will almost explain themselves. My dark room measures about 17×16 feet, by 14 feet high. The drying closet was made by partitioning off a corner 6×6 feet, the height being 9 feet. A cross-section of air-passage of one square foot area has been secured, both in the inlet and the outlet. The air is drawn from a veranda outside the house, and is discharged into the dark room, which itself has a large outlet ventilator in section somewhat resembling the inlet ventilator shown in the drawings. The closet is entered by a sliding door.

“The heat is got from an oil-stove which is enclosed in an iron case, from which an iron stove-pipe passes through the drying cupboard. This iron tube is made to pass through the inlet ventilator so that all incoming air must impinge on it, and the case holding the stove, as also the pipe, till it reaches the ventilator, and carefully covered with a thick coating of lime so that but little heat escapes.



The outside of the pipe is then at its hottest when it passes through the ventilator.

"The tortuous passage given to the air inlet has, of course, the effect of trapping the light, but the tortuousness serves another purpose, for no air can pass through such a passage without impinging on the sides, and by smearing these with molasses, all dust as well as light is trapped.

"Now for the performance of the closet. In the first place there is no perceptible difference in the times taken for tissue to dry in the different parts of the box. This state of affairs shows efficient ventilation, the reverse *always* shows some defect in the arrangement.

"The tissue dries as quickly if there is as much as can be conveniently hung in the room as if there is but little, and the time taken is about six hours in favourable weather, twelve hours in unfavourable. By favourable weather I mean that which is tolerably dry. The temperature needs to be but very slightly raised to secure rapid drying when the air current is brisk, and when the *incoming* air is heated.

"I was greatly assisted in arranging the drying closet by Mr. K. Ogawa."

It will be understood that the closet, exactly as shown in the cuts, is arranged for the drying of plates, the cross-bars being intended to support the plate-racks. These, however, are movable, and, when it is wished to dry tissue, all that is necessary is to take them out and to fix up a few horizontal bars, about 2 inches in diameter, at a height of about 2 feet below the roof. The tissue is then laid over these, the back, of course, being brought into contact with the wood.

Where gas is available it will be found far more convenient, as a source of heat, than oil, and a slow combustion stove might be used for a room on a larger scale. In any case the arrangement does not permit the escape of any of the products of combustion into the drying room.

The tissue when dry may be kept in rolls, but it will be found most convenient to cut it approximately to the sizes required and to keep it flat under pressure. It should be kept in a very dry place.

CHAPTER XXXV

CARBON PROCESSES—*continued*

Defects and Remedies in Pigment Prints

Insolubility of the Tissue.—This is probably the commonest of all difficulties in carbon printing. It is seldom that the whole film becomes insoluble. Only the very surface is generally affected, but this is quite enough to make it impossible to get pure whites in the prints, and also to prevent partly or wholly the adherence of the tissue to the temporary support. I have already stated how it is possible to tell whether tissue is afflicted with insolubility without actually making a print on it.

The cause of insolubility may be any of the following:—

(1) The use of very acid bichromate either incorporated with the tissue or in a sensitising bath.

(2) Slow drying of the tissue or drying in a warm, damp atmosphere.

(3) Drying in an atmosphere contaminated with products of combustion, etc.

(4) Long keeping, especially when there is a large quantity of bichromate in the film.

(5) Keeping in a damp atmosphere.

(6) Exposure to light.

(7) The use of an unsuitable gelatine in the manufacture of the tissue, as already explained, or the use of too little sugar.

The use of ammonia, as described, will prevent (1) the acidity of the bichromate.

The means of avoiding the other causes of insolubility are evident, but it is necessary to point out that, although the sensitiveness of carbon tissue is not *much* greater than that of common sensitised paper, it is necessary to be much more careful in guarding it against light. There are several reasons for this. In the first place, although there is no very great difference in the sensitiveness, *what there is* is in favour of the carbon tissue. Again, in the case of carbon tissue, there is no clearing action corresponding to that which we have in the fixing bath, in the case of a common silver print, in which any discoloration that is but slight will be removed; but the principal reason for the additional care necessary is to be found in *the continuing action of light* already described. On account of this action a very slight exposure to daylight will ruin tissue that has to be kept for a few days before exposure. It is certainly not too much to say that, at least in the case of tissue that is to be kept for a few days before use, it is necessary to exert *ten times* the care that is sufficient in the case of albumenised paper.

Frilling of the Film

This is by no means a very uncommon defect. The film leaves the support on which it is being developed, especially at the edges. This difficulty is particularly likely to arise if the film is insoluble, but it may be met with even if it be not.

It has already been explained that the object of the safe edging of the tissue is to prevent frilling. Care must of course be taken that the tissue is not cut so small that it is entirely within the safe edge, otherwise frilling is sure to result. If it be required to print a small piece only out of a negative, it is necessary to cut out a mask of opaque paper, or, much better, of paper of just such a degree of opacity that it will permit a slight tint to print, and to place this mask between the tissue and the negative.

The reason for safe edging on the *back* of the negative,

not on the film side, is that if there is an abrupt transition from a quite white margin to a deep shadow in a print the film is liable to frill off. The slight vignetting which results from having the safe edging on the *back* of the negative is enough to prevent this.

Frilling is likely to occur if the tissue be allowed to remain in the cold water too long before it is brought into contact with the temporary support. It should be applied rather before it has quite straightened itself out than after.

If too little time be allowed after the tissue and temporary support leave the cold water and enter the warm, frilling is liable to result.

When tissue is developed on collodionised glass, frilling is pretty sure to occur if the collodion film be scratched, torn, or punctured so that water can get under it.

Reticulation of the Film

is a defect somewhat analogous to frilling, and in fact may be termed incipient frilling. It is therefore likely to be brought about by the same causes which produce the latter defect. It will also show itself if time enough do not elapse after waxing the temporary support and before using it for development. A few hours at least should be allowed.

Reticulation appears to be particularly liable to occur when development is performed on a collodion film, and it is the writer's experience that it occurs more with tissue quite new, or newly sensitised tissue, than with that which has been kept for a few days. If reticulation show itself very obstinately on development on collodion, it may generally be overcome by giving the tissue a very brief exposure to diffused light before development. This exposure should not be enough to produce a perceptible tint after development.

Streaks and Spots in the Prints

These may be due either to the tissue or to the manipu-

lation during development, etc. Of course, if there are visible streaks and spots in the tissue before printing, it is only to be expected that they will show in the final prints, although, for reasons already stated, unevenness in the coating of the tissue does not *of necessity* produce unevenness in the resulting prints.

Spots in the tissue are commonly due to air bubbles. If there are any of these on the surface of the liquid sensitive compound, they should be skimmed off before coating begins. Of course any solid foreign matter in the compound will produce spots or streaks. If there be any such, the compound should be filtered before use.

Any roughnesses on the surface of the paper used as a support for the sensitive compound, in the form of small prominences, are liable to form nuclei for comet-shaped streaks when the paper is coated. The same remark applies to grease spots. Such streaks are also liable to occur if the gelatine has not been thoroughly stirred or churned up to mix it.

When the spots are not in the tissue, they generally arise from air bubbles confined between the film and the temporary support. Air bubbles are very liable to adhere unperceived to the surface of the tissue, and on development to produce spots. It is a good plan to pass the squeegee over the surface of the tissue *under water* just before it (the tissue) is applied to the temporary support.

The Prints are too Dark

This defect is generally due to over-exposure, but may be due to keeping the tissue after printing for even a comparatively short time in a damp atmosphere, in which what has already been described as the continuing action of light goes on very rapidly. The method of making the best of over-exposed prints has already been treated.

The Prints are too Light

This defect generally arises from under-exposure, but

if, even when what may be considered a protracted exposure has been given, the prints are still too light on development, the details in the lights being entirely washed away, it may be assumed either that too soft a gelatine has been used in the manufacture of the tissue, or that too little bichromate is incorporated in the film. Tissue showing the defect just described will be found to improve by keeping.

*The Print Developed on Collodionised Glass refuses to
leave the Support*

This is due to some fault in waxing the glass. Lambert laid great stress on the necessity for using *pure* wax and *pure* benzine. The plate must be very carefully cleaned before it is waxed, the wax must be very carefully spread over the *whole* of the plate, and must not be too completely removed, unless the removal be brought about by polishing with powdered talc, as already described. These precautions must be specially observed the first time a glass plate is used. When a print has once been cleanly stripped from it, it is very unlikely that trouble will result with subsequent prints. If a print sticks to a plate of glass, it is as well not to attempt to use that plate—or at any rate the same side of it—for squeegeeing another print to, even if it be carefully cleaned.

PHOTO-MECHANICAL PRINTING PROCESSES

Preliminary Note

A reference to the second chapter of this book, in which is given a brief sketch of the best known photo-mechanical processes, will show that the number is very great, and it will at once be seen that to give practical working instructions for all these would involve a work of great length, even were it possible to give such instructions ; but it is not possible as, in the case of many of the processes, the leading principles only have been published, the details of working have not, and to investigate them all would take more time than any one writer could give to the subject.

It is possible, however, to describe a series of typical processes, to one or other of which all photo-mechanical processes are more or less allied, and the thorough study of which by any one wishing to take up the working of any photo-mechanical process, should so far qualify him that nothing but intelligent application is further necessary to him. The Woodbury process is placed first because, as has already been said, it is the only true half-tone photo-mechanical process, and because it constitutes the master-key for various other processes, of which the first step is the production of a Woodbury relief.

CHAPTER XXXVI

PHOTO-MECHANICAL PRINTING PROCESSES

The Woodbury-type Process

Preliminary Remarks.—A little consideration of the carbon pigment process will show that an impression consists not only of various tints or gradations of pigment, but also of various amounts of relief, and that if this relief were to be obtained in any way, such as by casting the pigmented jelly in a mould, the gradation of tint or colour would follow as a consequence. A little further consideration will show that, inasmuch as the carbon image itself has relief, it might be made the means of producing a mould, were it first of all reproduced in negative ; and in fact the first attempts of Woodbury in working out his process consisted in taking negative reliefs from carbon prints by electro-deposition of copper. The process thus worked gave, however, no very satisfactory results, and it was not till Woodbury discovered that the hardness of a dry gelatine image in relief is such that it can actually be pressed into lead that his efforts met with success, the impression in lead of course forming a mould in which an image might be cast in pigmented gelatine.

A difficulty is, however, that the image in drying shrinks so that its relief becomes only a fraction of what it is when it is wet. For this reason some steps must be taken to secure a great initial relief. This is done by having a very thick film of bichromated gelatine with but little pigment in it, so that the light may readily penetrate it.

When the Woodbury-type process was first worked, the difficulty in getting a sufficiently high relief was much felt. At that time paper was not to be had nearly as smooth as it can now be obtained, and with a comparatively slight relief faults in the paper showed very plainly. It is now, however, possible to work with a relief in the final print of only $\frac{1}{2000}$ of an inch or even less, and as the relief of the print shrinks in drying by about ten times, this involves in the mould a relief of only about $\frac{1}{200}$ of an inch,¹ which is one that is not difficult to get if due precautions be taken. It will be evident that it is necessary to begin upon a film at least as thick as the relief required, and that initial thickness of film being sufficient, the depth or height of relief will be greater the greater the contrast in the negative, and the less the amount of pigment in the film. Indeed the pigment may be left out altogether when a negative of only moderate density *has* to be worked with. From a "thin" negative no tolerable Woodbury-type need be expected. If it is necessary to work from such, a negative of great contrast must be got by taking a transparency from the thin negative on a slow plate, intensifying it, taking a negative from it, and if necessary intensifying this latter also.

I shall suppose that a negative well suited to Woodbury-type work has been selected,—that is to say, one in which the gradation is good, but in which the extreme contrast between high light and shadow is somewhat more than would be considered desirable for the production of a silver print.

Preparing the Sensitive Tissue

The following formula, which is taken from the *Photographic News*, will be found to give satisfactory results:—

Nelson's transparent sheet gelatine	.	3½	ounces
Sugar	.	1	ounce
Glycerine	.	100	grains
Phenol	.	2	minims

¹ *Photographic News*, September 14, 1883.

Indian ink	2 grains
Ammonia (strongest)	60 minims
Bichromate of ammonium	300 grains
Water	12 ounces

The gelatine is set to soak in about 10 ounces of the water. The Indian ink is dissolved in the remainder.

The gelatine being thoroughly soaked is melted by the aid of heat, and to the solution are added the sugar, glycerine, phenol, and ammonia. The Indian ink and water are then added, and lastly, the bichromate of ammonium is stirred in, in a fine state of powder.

This formula, as I have said, will be found to give good results, but, bearing in mind that the process is exactly the same in principle as the carbon process, it will be evident that a formula suitable for the one will be suitable for the other too, and, as there is no use of multiplying formulæ, I advise that any one who manufactures his own tissue use the same sensitised jelly for the Woodbury as for the carbon process. The only thing to be observed is that the addition of a little glycerine is necessary, otherwise the film produced will be so brittle that it will certainly crack at some part of the process, and that much less colouring matter must be added. I have used the formula that I gave on the process on carbon printing with complete success. I repeat it here with the slight modifications necessary to adapt it to the Woodbury process.

Nelson's opaque gelatine	10 ounces
White loaf sugar	3 „
Glycerine	1 ounce
Potassium bichromate (dissolved in 5 ounces of water and converted into double chromate of potassium and ammonium by adding ammonia till the solution distinctly smells of it) .	$\frac{1}{2}$ „
Water	2 pints

Colouring matter in the form of Chinese ink, *quantum suff.*, as to be described hereafter.

The reader is referred to Chap. XXXIV. p. 260, for a description of the manner of mixing the jelly. The only matter that calls for special attention here is the colouring matter. On account of the extremely variable nature of Chinese or Indian ink, it is impossible to state the quantity that is needed. It is, however, very small, and the best way in which to work is to rub in ink till the proper density is got, the jelly being, of course, kept all the time in a liquid state by heat. It will be sufficient to say that so much colour should be added that, if a drop of the jelly is placed on a sheet of glass, is not spread, but is allowed to set as a kind of button, it should be possible to see the flame of a lamp through it, but only somewhat dimly. The films when coated in accordance with the instructions to be immediately given should show the same amount of transparency, for ordinary work at any rate.

Sheets of patent plate glass, which should be at least half an inch longer and broader than the picture is eventually to be, are prepared in the following way:—

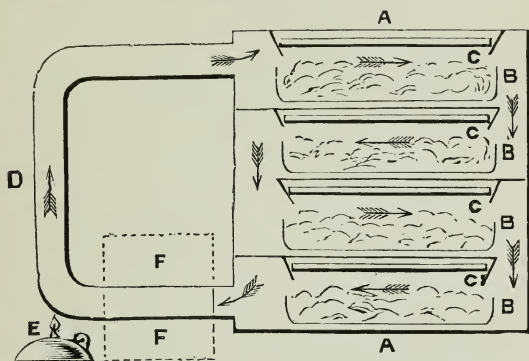
First the glass is treated with a waxing solution and with powdered talc exactly as described on p. 244, Chap. XXXII., for the “Lambert-type process.” It is then coated with collodion again as for the “Lambert-type process,” but the film, instead of being washed, is allowed to dry without the aid of heat. The solution is heated to about 150° Fahr., and is filtered through cambric. A plate is warmed, and is carefully levelled, and a measured quantity of the solution is poured on to it and is spread evenly over the surface, a glass rod being used to assist the flow. Strictly speaking, if the latter of the two formulæ given is used, a little more solution should be used than in the case of the former, as the latter is a little less concentrated, but for either about $\frac{1}{2}$ ounce for a quarter plate ($4\frac{1}{2} \times 3\frac{1}{2}$ inches) or 5 to 6 ounces per square foot will be found sufficient.

This film is comparatively very thick, and some special means have to be taken to dry it rapidly, otherwise it would be spoiled before the water was driven from it. The method used in drying Woodbury-type films is

generally one in which slightly heated air is caused to circulate first over dried chloride of calcium, then over the films. The chloride of calcium absorbs all (or practically all) the water from the air, which then very greedily absorbs the water in the films.

Various forms of drying box have been designed for effecting the desired end. The illustration here given is taken from the *Photographic News*. It shows a box which will answer the purpose as well as any other.

The films are ready to be placed in the box whenever the gelatine has set. I should have mentioned that all operations up to the point where the films are dry may be



carried on in moderate daylight ; when they are dry, they must be at least as carefully guarded from light as a sheet of sensitised-albumenised paper is.

The chloride of calcium is used in small fragments, which should be dried just before they are needed by heating them over a bright fire in an iron sand-pan or on a shovel. The same chloride of calcium will serve an indefinite number of times if it be always dried before it is used. A thermometer should be used and the temperature should be raised to about 80° Fahr. ; but should never, on any account, be allowed to exceed 85°.

When the films are dry, they are separated from the glass by the aid of a penknife. They are best used at

once, or within a day or two at the outside. Till they are put in the printing-frames, they must be carefully protected from damp by wrapping them up in tinfoil.

I have recently tried a way of drying Woodbury-type films that needs no special apparatus beyond a few boxes made of tinned iron, that is so simple and efficient that I think a description of it may be useful to readers. A few boxes, of exactly the same pattern as the cardboard boxes in which dry plates are commonly packed, of a size to hold the glass sheets on which the film is coated, are made of tin. These are half filled with chloride of calcium, and the plates are placed film side downwards over this latter. The boxes are closed, are placed in any warm place, when it will be found that the films dry within about twenty-four hours. The exact way of using the boxes so as to ensure the greatest possible efficiency is as follows:—The calcium is heated, is spread over the bottom of the boxes to a depth of half an inch, the boxes are closed, and are placed on one side till they become cool: they are then opened, a small cork is placed upright in each of the four corners of a box, and a plate is placed, with the film side downwards, so that the corners rest on the corks, the box is closed, and is simply set on one side, in any place where the temperature is about 80° Fahr., for twenty-four hours. It is essential that there should be not less than about half an inch of chloride of calcium on the bottom of each box, as this amount is needed to absorb all the moisture of the film. The films, on the glass, may be left for a very considerable time in the boxes, which thus form a convenient means of storing. I am not prepared to say how long films will keep in the “calcium boxes” that I have just been describing, but I have found them good at the end of ten days. I imagine that, if the space between the lid and the box were secured by pasting any water-tight material over it, they would keep for a very long time. By drying as I have just described, the chances of damage from dust are reduced to a minimum.

It is usual to make films of the kind just described for Woodbury-type, and, if the directions given be duly

attended to, no great difficulty will be found to be in either making or developing them, but I have recently found it more convenient to use a very thick carbon tissue with a paper support prepared exactly as will be described in the next chapter, that on Stannotype. If the description of this tissue be read, it will at once be seen that it is quite applicable to Woodbury-type, the face of the tissue being exposed to the negative, and the paper being stripped away, a little time after development begins, or, rather, a little time after the tissue has been placed in contact with its support in the water, but before development begins.

The Exposure

The quality of negative suitable for use to produce a Woodbury-type relief has already been described.

The film is placed in the frame collodionised side next the negative, and a piece of tinfoil or a plate of glass is placed on the back of it to protect it from moisture. For the means of determining the length of exposure, I must refer the operator to the chapters on carbon printing. An actinometer must be used with the Woodbury tissue as with carbon tissue, but the exposure must be somewhat longer, even after allowing for the unusually dense negative that is recommended. It is, however, rather an advantage than otherwise to print in full sunshine, the plane of the negative being kept at right angles to the direction of the sun's rays. In such cases, working with the second of the two formulæ given, and using negatives with good gradation which give very brilliant silver prints, I have found an exposure of an hour necessary.

It should be mentioned that the films should be quite flexible without being tacky. If they are so brittle that it is difficult to handle them without their cracking, this is proof that too little glycerine has been used. If they are tacky, so that, for example, there is a tendency for the film to stick to a plate of glass placed behind it in the printing-frame, this shows that too much glycerine has been used.

The image is visible if but little or no pigment be used, but it is not advisable to open the frame to examine it, lest the tissue be attacked by damp, which may have the effect of rendering it insoluble even in hot water, and therefore undevelopable.

Development of the Image

The exposure over, the film is ready for development, which goes on in the same way as that of a carbon print, but takes a much longer time on account of the excessive thickness of the film. It is necessary to attach the tissue to some rigid support during development, to prevent it from collapsing altogether. There is nothing better for a support than glass, and no better substance for fixing the tissue to the glass than rubber dissolved in benzine. The thick rubber solution, which is sold in tins, may be used, being thinned down with benzine or benzole, so that it will flow like collodion. The benzine should be as pure as it can be procured. Gum Para, which is a very pure form of rubber, may be dissolved in benzole in such quantity—perhaps about 5 grains to the ounce—as will result in a liquid of the consistency mentioned.

Glass plates are flowed with the solution as with collodion, but as little excess is poured off as possible, the plates being levelled till the rubber has set or assumed a “tacking” consistency, which may take an hour or two. A film is now brought into contact with a rubber-coated plate by bringing the collodion side of the former into contact with the latter, care being taken to avoid air bubbles by bringing one edge of the film first in contact with the plate if the size be small, a line from one corner to another opposite if it be large. Pressure is now exerted to bring about close contact. If a rolling machine with rubber rollers be at hand, such as an ordinary wringing machine, it may be used, or a machine with metal rollers may be used by placing a thick sheet of rubber below the plate and another over the image to prevent breakage.

It is quite essential to secure perfect contact between

the glass at this stage of the proceedings, but this is not always very easy. It is essential that the rubber be of good quality, and I have found that improved contact resulted from coating the *film* as well as the glass. A few drops of the rubber solution are poured on the collodion side of the film, and they are spread over it with the fingers. A very thin film of rubber is thus got, which may be dried by gentle heat in a minute or two. I have found it possible, in the absence of proper rollers, to secure contact by placing a pad of paper over the film, and going over this with a "burnishing" motion with the ivory handle of a knife, or other burnisher-like object.

The development is done solely in hot water, and must be allowed to go on spontaneously, patience being the great thing necessary. Some means must be arranged for keeping the plate under water in a vertical plane. Nothing is better for this than a metal-grooved box, in which a number of plates can be developed at one time. At first the temperature should not exceed 110° Fahr., or, perhaps still better, 105° , and the water should be changed frequently. When the bichromate salts have all been dissolved away, the water coming off quite colourless, the temperature may be raised till eventually it reaches as high perhaps as 150° , or even 160° . As already stated, time must be allowed, the development is seldom complete in less than two hours, and may take as long as two days. The progress of the action may be observed from time to time by removing the glass bearing the image from the water. It will be readily enough seen if there be pigment in the film, as the image should then appear as a perfect transparency. If there be none, the effect is best judged of by passing the finger over the film, when the relief can be judged of. A relief without pigment has by no means a very promising appearance, but this need by no means discourage the operator.

Development should be continued till the parts of the film representing the high lights are dissolved away all but to the collodion. By this time, if the exposure have been right, the whole of the surface should be covered

with modelling, but the highest relief should still represent the whole thickness of the film or nearly this,—that is to say, but little gelatine should have been washed from the parts which represent the deepest shadows of the print. If the exposure has been too long it will not be possible to dissolve away the lights to the collodion film, if it have been *much* too long great parts of the film will show the original surface, no gelatine having been washed from it at all, and prints with heavy dark shadows will result. If, on the other hand, the exposure has been too short, the whole thickness of the film will be so reduced that the relief will be but slight, and only weak, poor prints can be expected ; moreover, the lights will be wanting in modelling. Probably over-exposure might be compensated for to a certain extent by adding a little ammonia to the developing water, as is sometimes done in the case of over-exposed carbon prints.

When it is judged that development is complete, the plate is rinsed for a few minutes in a stream of cold water. It is then placed for ten minutes in a 4 per cent solution of chrome alum to render it as little likely to be subsequently attacked by moisture as possible. It is then once more washed in cold, or tepid, water to get rid of the chrome alum, is allowed to drain till it has become surface-dry—till all drops of moisture have run from it, that is to say—and is placed in a dish of methylated spirits to remain there for an hour. It is then allowed to dry like a dry-plate negative.

When the film is quite dry, it is removed from the glass by inserting the point of a penknife under one corner and gently dragging it away. The rubber comes with it, but may be removed by laying the film on a flat surface and rubbing with the tips of the fingers. The rubber is thus *rolled* off in little balls. Any pin-holes in the negative or accidental marks which would print *dark* in the final print will show as projections on the gelatine relief, and may be removed by a strip of glass broken square across. A skilful Woodbury printer may, in this way, do much to improve a relief, but the beginner should confine himself to the

removal of such sharp projections as will result, if left, in small dark spots.

The relief having reached the stage indicated is ready to be used for the production of moulds in lead ; but "it is not desirable to make immediate use of the relief, as it continues to contract slowly for some hours after its removal from the glass plate ; and until it has attained its normal condition of equilibrium, it is liable to break up under the influence of pressure."

The most convenient method of storing away the reliefs is to make up books out of envelopes ; the open sides of the envelopes being directed inwards towards the back of the book. This arrangement affords great facilities for indexing the subject.¹

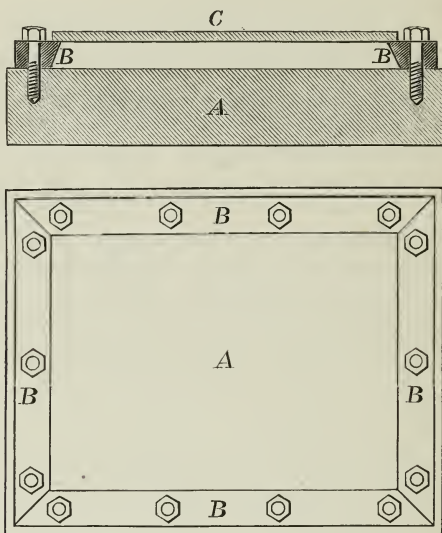
Production of Lead Moulds from Woodbury Reliefs

For the production of lead moulds from Woodbury reliefs all that is necessary is a machine for pressing the relief down on to the lead with sufficient pressure to drive the hard gelatine into the substance of the metal. But this "all" is something very considerable, as the pressure needed is much greater than might be imagined—is, in fact, something enormous. It needs a pressure of nearly 4 tons per square inch of the surface of the relief,—that is to say, about 50 tons for a quarter plate, 200 tons for a whole plate ; the latter size being about the largest commonly worked, chiefly on account of the great pressures required for larger sizes.

Fortunately the manufacture of hydraulic presses for giving great pressures has now been brought to a high degree of perfection ; the presses, moreover, being remarkably compact, and, considering the very great pressures given by them, very light. The length of stroke needed for producing Woodbury moulds is also, fortunately, very small. A press, to give the greater of the two pressures mentioned (200 tons), may be purchased from Tangye Brothers, of Queen Victoria Street, London, for about £50.

¹ *Photographic News*, March 21, 1884.

In addition to the press, a plate of steel is needed to receive the relief. This may, with advantage, be an inch thick, or nearly so, and must be planed and scraped up as true as a surface-plate on its upper side. It has then fixed to it bars of steel, to prevent the lead from spreading at the edges when the pressure comes down; the bars enclosing a sort of trough a little larger than the relief. The annexed cut will serve to illustrate the matter. A is the



steel plate, B, B, B, B are the steel bars, which may be $\frac{1}{2} \times \frac{3}{8}$ inch in section, slightly bevelled away at the inner edge as shown.¹ They are fixed with set screws. C is the lead plate about $\frac{1}{4}$ inch thick, polished on its lower side, and smooth on both sides. The platen of the machine is made just to fit within the bars B, B, B, B, so that when it comes down it cuts off the edges of the lead plates.

The relief is placed on the plate A, the lead plate is

¹ The amount of bevel shown in the cut is rather more than is advisable in practice.

placed in position as shown, one or more thicknesses of millboard are placed on the top of it, the platen is brought down with full pressure, and when it has been raised and the lead is removed, it will be found that a perfect mould has been produced, and such moulds may be multiplied almost indefinitely.

The best moulds are produced when the relief is laid with the collodionised side next to the steel plate; but it will be seen, if all the steps of the process be followed, that the result is a reversed print. If this be objectionable two courses may be followed. In the first instance a reversed negative may be produced. As the ordinary run of negatives are too thin for good Woodbury-type work, and as it would be objectionable to intensify them, thereby destroying them for ordinary work, it is very often advisable to reproduce the negative, getting one showing greater contrast than the original, as already described. If this be done, the opportunity should always be taken to reverse the reproduced negative, by taking either the transparency from the original negative or the reproduced negative from the transparency in the camera; whichever is done, the plate photographed *from* being turned with its film away from the camera.

If this be not done, the relief must be laid on the steel plate, with the collodion side uppermost, and the first few moulds must be rejected. Those following will be to all intents as sharp as if produced with the collodionised side downwards.

The printing from a Woodbury mould is done in the same way as that from a Stannotype relief, and is described in the next chapter, which treats of the latter process.

CHAPTER XXXVII

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Stannotype

General Principles.—The reader of the last chapter will have perceived that the necessity for a hydraulic press in working the Woodbury-type process is quite enough to prevent it from becoming popular, in the sense of being worked by a number of photographers producing only on a small scale, or by amateurs. The object of the invention of the Stannotype process (also by Woodbury) was to do away with the necessity for the press.

A consideration of the principles of the Woodbury process will make it evident that were the gelatine relief produced from a positive, in place of from a negative, and could this relief itself be used as a mould for the direct production of prints, nothing further would be needed. Now the only objection to the use of the gelatine relief itself as a mould is that the direct contact of the ink or pigment used in printing—which consists merely of gelatine and colouring matter in water—would destroy it, by reason of wetting it. This difficulty was overcome by Woodbury by the expedient, which appears, *after* it has been explained, as one that would be adopted as a matter of course, of protecting the relief by a sheet of tinfoil pressed into close contact with it.

The Transparency

As has already been said, the relief to be printed from

direct must be produced from a transparency, or dia-positive, in place of from a negative. This transparency may be made by any of the well-known processes for making transparencies. The same qualities are needed as for a negative for the Woodbury-type process—namely, a great range of density. Moreover, if a reversed print be not admissible, the transparency must be reversed. It must therefore, unless the negative is a reversed one, be prepared in the camera, or by single transfer in carbon. The last-mentioned process is the most commonly used—a carbon transparency being produced and being intensified with permanganate of potash, as already described in the chapters on carbon printing. Probably gelatino-chloride plates would give very good results.

In whatever way the transparency is made, it is necessary that it should have an edging of clear glass, and also that the highest lights should be quite clear. The edging may be $\frac{1}{8}$ to $\frac{3}{16}$ inch in width. If the high lights be not quite clear, the high lights of the final prints will not be clear either; or, to speak more precisely, if the high lights be not as transparent as the edging, they will not print white. If *both* have a slight tint of the same depth no ill will result.

The Relief or Mould

A suitable transparency having been got, a relief is made from it in precisely the same manner as that described for the production of a Woodbury-type relief. This may be made on a film of the kind described in the last chapter, but the way there described for making the tissue or sensitive film is only one of many that are in use. For example, the film may be first dried without the addition of bichromate, which may be afterwards added by sensitising in a 6 per cent solution of that salt. The tissue may be prepared by thoroughly wetting a piece of paper, laying it on glass, running the gelatinous solution on the paper, stripping the two together from the glass, hanging them up to dry in an ordinary room, and afterwards sensitising. I believe Woodbury himself used shallow glass dishes which he slightly

greased, into which he ran the gelatine solution. He allowed this to dry, then brought a piece of damp paper into contact with the upper surface. The paper adhered, the thick film of gelatine was drawn by it from the mould, the paper quickly dried, when the resulting tissue was sensitised in a solution of bichromate of potash and dried.

A paper-supported tissue is particularly convenient in use if it can be dried without curling up to such an extent that there is great difficulty in getting good contact between it and the negative or transparency. There is a great tendency to such curling, which is, of course, due to the great thickness of the coating of gelatine. I describe here exactly the way in which I have found it quite easy to make tissue perfectly flat, so that contact can be got with the greatest ease.

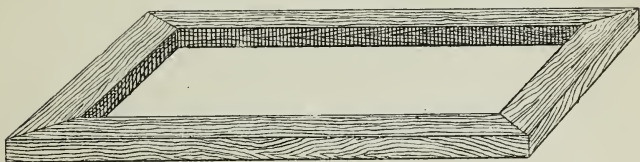
Either of the bichromated gelatine solutions described in the last chapter may be used. Any good quality of paper—good white notepaper will do very well—is cut to sizes an inch greater in length and breadth than the intended reliefs. A sheet is wetted, is blotted off, and is laid on a plate of glass larger than itself, which is carefully levelled. An eighth of an inch of the paper is now turned up around the edges. A sort of dish is thus made, and into it is poured the solution to about the extent of five or six ounces the square foot. The glass is slightly tipped to make the solution flow into all the corners of the dish, and then the whole is left till the gelatine has set.

Light wooden frames, of the shape shown in the cut, made of hard wood measuring about $\frac{1}{4}$ inch thick and $\frac{1}{2}$ inch wide, are used to support the tissue in drying. The backs of the sheets are attached to these frames with stiff glue, applied for $\frac{1}{4}$ inch along each edge, and the frames supporting the tissue are placed in the calcium cupboard or in calcium boxes, just as if they were glass plates supporting films. In drying the paper shrinks, and becomes as tight as the skin of a drum. The drying goes on from both sides, and, for this reason, is quicker than in the case of films supported on glass. In fact it is possible to dry without calcium chloride at all if the conditions are favourable.

The time taken, however,—generally about two to three days—is such as to seriously endanger the quality of the film, not to mention the fact that during that time some dust is almost certain to attach itself to the damp gelatine, producing eventually spots.

When the tissue is dry it is removed from the frame by cutting round the inner edge with a knife. There is thus a loss of a part of the tissue, but the materials used are, in the matter of price, so small an item in working the Woodbury or Stannotype that the slight loss will not, I think, be considered as balancing the advantages of the method of working that I have been describing.

Of course, when paper is used as a support, the side remote from the paper is brought into contact with the



negative, being attached to glass by india-rubber solution just as already described.

The paper will, of course, detach itself from the tissue as soon as development begins.

The tissue having been prepared by any of the methods described, exposed, developed, and dried, is allowed to remain on the glass plate, which should be thick and quite flat.

It is now only necessary to coat the surface with tinfoil when the mould is ready to be printed from.

If only a few impressions—say a hundred or two—are needed, ordinary tinfoil will serve the purpose; but if a great number be wanted, steel-faced foil made specially for Stannotype work should be used.

A piece of the foil a little larger than the relief is examined by holding it in front of a light to see if there are any pin-holes. If there are any it must be rejected, as the smallest pin-hole would allow the gelatine under the tissue

to get wet, and would, if it led to no worse result, produce a white spot on each print from the swelling of the gelatine.

The tinfoil is laid out on a piece of glass, and is flattened with a velvet hat-brush or a piece of velvet stretched over the ball of the thumb. The relief is then prepared in the following way:—The edging, which is in high relief, is coated with a thick solution of rubber in benzine or in chloroform. When this is set, the whole surface is flowed with a thin solution of rubber, in the manner usual with collodion. The best rubber to use is gum para, and a good strength of solution is 2 grains to the ounce. *Pure* benzine will do very well as a solvent, but chloroform is preferred by some.¹

Whenever this film has set the sheet of tinfoil is brought carefully down on to the surface of the rubber, it is smoothed into rough contact with the velvet brush, and then is brought into intimate contact by passing the plate bearing the mould and the tinfoil sheet between two rubber rolls, the ordinary domestic wringing machine serving every purpose. The rolls are opened, the plate is inserted, and the rolls are closed across the middle of it. They are then worked first one way then the other for two or three times, when the mould may be looked upon as complete. Before printing from it, it is carefully oiled with a rag dipped in olive oil, which has been thinned down by the addition of about an equal quantity of thin paraffin oil.

Printing from Woodbury and Stanotype Reliefs

As has already been said, the process of printing from a relief is in fact a process of casting. Into the relief or mould a certain portion of a solution of gelatine and pigment is poured, paper is placed over this, by pressure the excess of pigmented gelatine solution is squeezed out, and what remains is allowed to set. It adheres to the paper and comes out a perfect *casting* of the mould, showing relief,

¹ See an excellent series of articles on Stanotype running through the *British Journal of Photography* for 1884.

and, as a secondary consequence of this relief, *gradation* of colour.

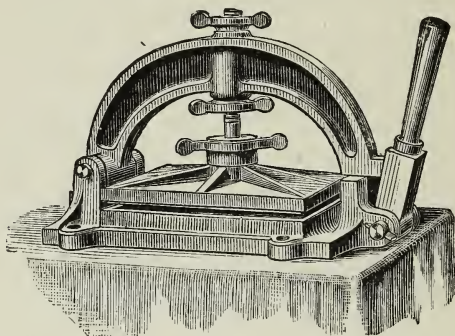
The first essential for printing from reliefs is a suitable paper, one, that is, with a perfectly smooth surface. To begin with, a good paper of even texture is selected, such as Rives's photographic paper. This is then treated with a "lac" or sort of varnish which is made up as follows:— "4 ounces of borax and an ounce of carbonate of soda are dissolved in 3 pints of water. The solution is heated to the boiling-point, and a pound of white shellac is added, the boiling being continued till the whole is dissolved. When cold, the liquor is made up to its original volume, and a little carmine is added to give it a faint tint; this being an advantage, as it renders it easy to distinguish the coated side of the paper." The coating is then performed in the following manner:—

"The room in which the coating of the paper is carried on should be kept warm; it is not desirable that the temperature fall below 90° Fahr. The solution is filtered into a tolerably deep dish, this being inclined a little so as to give an increased depth of liquid in that part of the dish next the front edge of the table. Two sheets of paper are now taken and are held by opposite corners, so as to keep two edges in close contact, and this double edge is quickly immersed in the shallow part of the dish, after which the two sheets are rapidly drawn forward and brought out of the solution at the deep edge of the dish. The sheets adhere at the edges, but the liquid does not penetrate more than an eighth of an inch from the borders. The double sheets are now pinned up to dry, when they are separated, the most convenient course being to cut off a slip one-eighth of an inch from one edge and then to use a paper-knife. . . . Still another coating is required. . . . A kind of emulsion of gelatine and resinous matter is made by dissolving 1 part of gum benzine in 10 parts of alcohol. After the solution has been filtered, it is mixed with a warm solution of 1 part of gelatine and 9 parts of water, care being taken that violent agitation accompanies the mixing. The milky fluid is applied to the surface of the

lac-coated paper by means of a soft cloth, it being sufficient to thoroughly moisten the surface.”¹

The paper after it has dried needs to be carefully rolled by passing a set of alternate sheets of paper and thin polished steel plates through a powerful rolling press. The paper, after it has been prepared as described, must be handled with the greatest care, as the smallest roughness produced by crumpling it will show as a blemish in the finished print.

The next necessity for printing is a press. This is a comparatively simple piece of machinery. In fact, any press working with a platen which will give a moderate



pressure, is applicable for Woodbury printing, but the press specially designed for the work and illustrated here will be found the most convenient.

It will be seen that the press has something of the form of an ordinary letter copying press, but that the bow or arch is hinged at one end, so that it, with the platen, can be raised up. There are also three nuts on the screw. The object of these three nuts is to obtain (1) adjustment of distance between the bed of the press and the platen—in which latter is inserted a thick sheet of plate glass—for different thicknesses of mould; (2) adjustment of angle of the platen in case of want of parallelism between the two faces of the mould; and (3) adjustment of pressure to a

¹ *Photographic News*, April 10, 1884.

desired amount, which can then be repeated by simply lowering the arch.

The mould is placed on the bed of the press, a piece of wet cardboard being placed under it to prevent breakage if it be a Stanotype mould. The three screws are loosened and the platen is allowed to come down on the relief. The screw immediately below the arch is now screwed upwards with some force. This applies the pressure. The top screw is now tightly screwed down. This connects the screw rigidly with the arch of the press. The lower screw, which clamps the ball-and-socket-joint connecting the screw with the platen, is now firmly turned home, when the platen is found to be rigidly connected with the arch, so that it will always come down with the latter to precisely the same position.

The ink or pigment has next to be considered. This is, as has already been said, simply gelatine, water, and colouring matter. A hard gelatine should be selected. Heinrich's gelatine for emulsion work will be found very suitable, and 1 part of this is dissolved in 5 parts of water. The amount of colouring matter needed can only be discovered by experiment as it varies with the depth of the mould, being *less* the deeper the mould. As a rule, Indian ink forms the body of the colour, and tone is given with carmine or some such colour. To save the trouble of grinding the ink, the liquid form sold by colourmen may be used, or "colour for carbon printing" may be obtained ready mixed to the desired tint and tone from Newman, 24 Soho Square, London, W. A first trial may be made with so little colour in the ink that a drop of the compound on a sheet of glass is still somewhat transparent.

George Smith, who is an authority on Woodbury-type printing, uses, for producing lantern slides by the process, a "lamp-brown," got by collecting the smoke from the tip of the flame of a small lamp burning benzine. The colour is very rich, and has the advantage of undoubted permanence, whereas, if carmine be used to give tone to lamp-black, the redness of the colour may fade through time, leaving black only. He also adds a little bichloride of

mercury to the ink, which prevents the gelatine from decomposing or becoming mouldy.

The jelly, consisting of 1 part gelatine, 5 parts water, will work well in summer, but may be found too stiff in winter. In this case more water is added and also more pigment.

All being now ready for printing, and the mould having been oiled with the oily cloth already mentioned, the arch and platen of the press are lifted, enough ink is poured into the mould to form a pool of about half the diameter of the picture, a sheet of paper is carefully laid on it, somewhat as a sheet of albumenised paper is laid on the silver bath, the platen is brought down, and the whole is left for a few minutes to allow the gelatine to melt. The print is then removed and is examined to find if the ink has been rightly compounded and if the press is properly adjusted.

If the edges are not white, it shows that the pressure is not sufficient, or that the jelly is too strong. The pressure should be readjusted, screwing the screw immediately under the arch more tightly up than before, then locking with the upper nut. If the same defect still shows, the ink must be diluted with water. If the impression is generally too light, it shows that more colouring matter is needed in the ink. If the impression shows clear margins, but is generally too dark, it shows that there is too much colouring matter in the ink, and it must be diluted with jelly containing no colouring matter. Any of these points which need it having been adjusted, printing may go on regularly. The oily cloth is wiped over the mould after each impression has been taken. The speed of printing is limited by the time taken for the gelatine to set. When large numbers of prints are needed, a number of moulds and presses are used, these being filled and emptied in succession. The thick edging of ink that adheres to the prints is removed with a spatula, and is kept for future use, as is also the ink that finds its way into the groove around the platen of the press. The prints are commonly treated by immersion for five minutes in a 3 per cent solution of common alum before they are dried, so as to render them

insoluble, and therefore less liable to be attacked by damp. After they have passed the alum bath, they are rinsed in water and are allowed to dry spontaneously. They are improved by heavy rolling after they are dry.

The only drawback of the Woodbury-type and Stanno-type processes is that it is not possible to get large surfaces of pure white, or of an even very light tint, and specially is this difficult at or near the margin of the picture. For this reason vignettes cannot be printed by these processes.

CHAPTER XXXVIII

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Photo-Lithography

General Principles.—The photographer, who has no knowledge of ordinary lithography, can scarcely expect to be able to work photo-lithography, unless he practises that process for some little time, or calls in the assistance of a skilled lithographer.

To give full instructions in lithography would be quite out of place here. Indeed, it would involve a complete treatise quite as long as this whole book. I shall, however, explain very briefly the manipulations of the simplest lithographic work, and refer the photographer to an excellent manual on lithography for further aid—namely, *The Grammar of Lithography*.¹

The principles on which the process of lithography depend have been very briefly explained in the introductory chapters. The following are, briefly explained, the actual manipulations :—

On a lithographic stone (which is a slab of a particularly homogeneous limestone found in certain parts of Germany, carefully ground on one surface) a drawing is made, or writing, etc., is done with an ink which consists essentially of grease dissolved in water by the aid of soap, which latter has the effect of rendering oily substances soluble in water.

¹ *The Grammar of Lithography*, a practical guide for the artist and printer, by W. D. Richmond. London: Wyman and Sons, Great Queen Street, Lincoln's Inn Fields, W.C., 1880.

The ink contains black colour merely for the purpose of making the marking on the stone quite clear, and of enabling the draughtsman to see what he is doing. The designs must be reversed. The surface of the stone is now treated with very weak nitric acid to etch it as is said. The process is, however, not in reality an etching one—or rather, although the acid does very slightly *etch* or eat into the stone, this etching is not apparently the really useful function of the acid. What it further does, and what is its essential function, is to neutralise the alkalinity of the soap, which in reality amounts to decomposing it. Soap consists of a combination of oil and alkali, the alkali being in excess, so that a certain quantity more of grease can be dissolved, or perhaps it would be more strictly correct to say emulsified in a solution of the soap. When, however, the alkali is neutralised, the oil of the soap itself, and also any oil or grease that may be emulsified in it, are deposited. The application of the acid to the stone then releases the oil and grease, which sink into the substance of the stone, so that no amount of washing will eradicate it. Besides fluid ink crayons or “chalks” may be used for drawing on the stone. These may be looked upon really as solidified ink. The stone having been etched is “gummed,”—that is to say, is washed over with a thick solution of gum-arabic in water. The precise action of the gum seems scarcely to be understood, but it greatly improves the working of the process. The gum “takes” on the parts of the stone where no ink has been, and appears almost to form a combination with the lime. At any rate it cannot be washed out of it again with water.

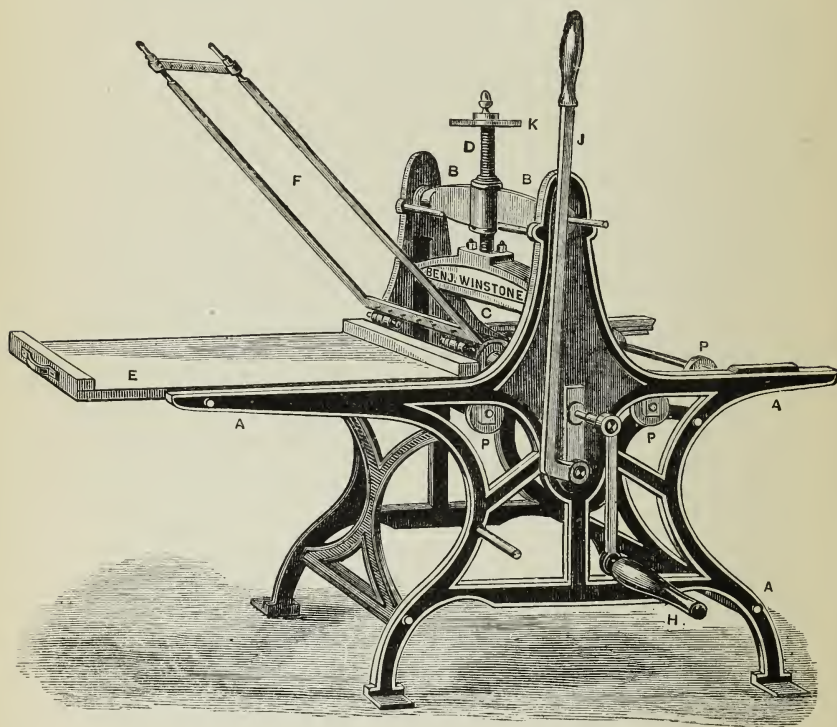
Zinc may be used in place of stone, the surface of the plate being, as a rule, previously grained with sand, pumice stone, etc., and the gum solution being replaced by a mixture of gum, nut-gall extract, and phosphoric acid.

Whether stone or zinc be used, the printing is performed in the following manner:—

The surface is damped and is “inked up” by a roller which has been inked on a slab, on which is spread a film

of lithographic printing ink. This ink consists essentially of a mixture of colour (generally lamp-black), with "varnish," the varnish consisting simply of linseed oil thickened with heat.

The ink "takes" only on the parts that have been drawn upon, and when a sheet of paper is brought to bear



on the surface with sufficient pressure, the ink is taken up by the paper, giving a perfect impression. The operations of damping, inking up, and printing may be repeated indefinitely.

The machine used for printing is a very simple one, and as it is the same as is used for printing photo-lithographic transfers, an illustration of it is given.

Here E is the bed on which the stone is laid. This bed can travel from end to end of the frame, A, A, being caused so to do by turning the handle H.

In travelling it passes under the "scraper box" C, which contains the scraper. This latter is simply a strip of boxwood, the length of the scraper box 3 or 4 inches deep and about 1 inch thick, faced on its lower edge with a strip of leather.

In printing, the bed is caused to travel under the scraper, being pressed upwards by a mechanical contrivance actuated by the lever J. This causes the scraper to rub the back of the paper, which is placed on the stone with an even pressure.

F is the tympan frame, whose function is merely to hold a stretched piece of leather or thin sheet metal to be interposed between the paper and the scraper, so as to protect the former from being torn or otherwise damaged.

Lithographic Transfers

It has already been said that if drawing or writing be done directly on the stone it must be reversed. To obviate the necessity of writing, etc., in a reverse direction—a thing needing some practice—the *transfer* method is used. Paper is coated with gelatine, gum, or starch, or mixtures of these, and of various other substances. Almost any substance which can be drawn on with lithographic ink, into which such ink will not soak, and which can be afterwards dissolved away by cold or warm water, will serve, the object being to interpose a soluble film, afterwards removable by the application of water, between the paper and the design in lithographic ink.

The design being produced on the transfer paper, the latter is damped and is brought into contact with the stone, which may be dry, damp, warm, or cold according to the nature of the transfer paper and various other circumstances. The stone or zinc plate and transfer paper are now passed several times through the machine. The paper is removed by thoroughly damping it and treating

it with warm water, and the composition is also washed away, leaving the design only on the stone, which is then etched, gummed, and printed from in the usual way.

Transfers can also be taken from type work, woodcuts, etc., by taking impressions from these on transfer paper, and transferring these impressions to stone or zinc.

Photographic Transfers from Line Subjects

The principle on which photographic transfers from line subjects are made will now readily be understood if briefly described.

Photographic transfer paper is prepared like ordinary transfer paper with gelatine, with sometimes additions of starch, gum, albumen, etc. It is, however, different from ordinary transfer paper, in that it is rendered sensitive by the addition of some bichromate of potassium or ammonium. The sensitive paper is exposed under a negative of a line subject, when the nature of that part of the surface affected by light is modified in a peculiar manner. If the exposed transfer paper be now rubbed all over with lithographic ink, this ink may subsequently be washed away from the portions which have not been acted upon by light, but adheres to those parts which have, so that an image in ink which may be transferred to stone is obtained.

I give several formulæ for composition wherewith to coat paper for photo-transfer films :—

No. 1

Nelson's No. 1 gelatine	1 $\frac{1}{2}$ ounce
White loaf sugar	$\frac{1}{2}$ "
Bichromate of potassium (converted into the double chromate of potassium and ammonium, by the addition of ammonia)	40 grains
Water	1 pint

The gelatine is soaked in all the water but an ounce or two, and, when soft, is melted by the application of heat.

The bichromate is dissolved in the remainder of the water, heat being used to assist solution if it be considered advisable. Ammonia is then added drop by drop, till the solution turns yellow and smells distinctly of ammonia, exactly as described for the carbon process (Chapter XXXIV. p. 259). The solution is then added to the melted gelatine. The sugar may be added at any time, so long as it is thoroughly dissolved. The whole must be strained through flannel, or, better still, "swan's-down calico."

As to the method of coating the paper, the following is that generally recommended. The solution is poured into a flat dish with an outer dish filled with very hot water, so as to keep the heat of the solution a good deal above that necessary to prevent it from setting. A temperature of about 140° to 150° Fahr. will not be found at all too hot.

The paper used must be of good quality, but the exceedingly fine paper used for silver prints, etc., is unnecessarily good. "Bank post" paper will be found suitable. This is floated on the solution for about a minute, and is then raised by two corners, and is hung up to dry. To secure evenness it is usual to refloat the paper after it is dry, lifting it this time by the two corners that were the lower ones before. The writer has found great difficulty in getting an even film in this way, and, if the film is very uneven, the result will be blurred lines where it is thick, and, in fact, general unevenness of the image. He has been more successful in coating long strips, by unrolling them over a trough of the solution exactly as is described for the coating of carbon tissue in Chapter XXXIV., but he recommends the following as a simple and very efficient plan, at least where the sheets are not of large size. It has the advantage, at least in the hands of one accustomed to the coating of glass plates with emulsion, of giving a very even film, and of giving paper which is perfectly flat when dry.

The paper is cut an inch longer and an inch broader than it is eventually needed. A number of planed boards, which may be of common deal, but should be about an inch thick to prevent them from warping excessively, of

the size of the paper are provided, as also a number of common sheet glass plates the same size.

The sensitive composition is placed in a teapot, a sheet of the paper is thoroughly wetted, is laid on a sheet of glass, the excess of moisture is blotted off with a sheet of blotting-paper, and the paper, supported on the glass, is coated exactly as a glass plate is coated with emulsion, that is to say, a pool of the composition is poured from the teapot on to the paper, the plate is tipped till the liquid has spread itself all over the surface, a certain proportion of the fluid is allowed to run off, and the plate is rocked till the remainder has spread itself in an even film, when it is placed on a perfectly level table.

When the gelatine has set in the form of a jelly the paper is stripped from the glass, is laid on one of the boards, and is glued down to it round the edges. It dries perfectly flat. Frames might be used like these recommended for Stanotype, in which case the drying would certainly be quicker, as the air would get access to the paper at both sides, but, the films being comparatively thin, dry quite quickly enough on the boards. The paper is removed from the board by cutting off a narrow strip with a penknife. Those who are familiar with the two operations of coating plates and of stretching drawing sheets, will know that the operations are simpler than would seem from reading a description, whilst the results are incomparably better than those to be had by any other way of working that I know of.

It need scarcely be said that this paper needs to be dried in a dark room. The conditions of drying are exactly the same as for carbon tissue, and the reader is referred to the chapters on the carbon process for information.

Where work is done on a small scale, it may be convenient to omit the sensitising bichromate in the gelatine solution, and to sensitise the paper afterwards. If the paper be prepared exactly as indicated, but without any bichromate in the solution, it will keep indefinitely. It may be sensitised for use in precisely the same way as carbon tissue (see Chapter XXXIV. p. 261).

In most formulæ that I know of the addition of ammonia to convert the acid bichromate into the neutral double chromate is not recommended. It is, however, of decided advantage, making the paper keep at least twice as long as it otherwise would, and reducing to a minimum the tendency to "surface insolubility"—an exceedingly annoying defect that is liable to set in during drying. In fact, paper prepared exactly as I have described, will remain in good condition for two or three weeks if due care be taken.

No. 2

The paper prepared with sensitive gelatine and dried is afterwards coated with the following solution:—

Albumen	3 ounces
Bichromate of potassium (converted with ammonia as described above) . . .	80 grains
Water	10 ounces

The albumen is switched and filtered as for albumenising paper (see Chapter VII.), but of course has no salt added to it. The potassium bichromate is added to the water, and the water and albumen are mixed.

If the paper has been evenly coated at the first, and if it has been reduced to a state of tolerable flatness, no difficulty will be experienced in giving the second coating. The operation may be performed exactly in the same way as paper is albumenised for silver printing.

No. 3

Paper is coated with a simple solution of gelatine, which may be made of a strength of 10 per cent. This paper is, after the gelatine has set, treated by immersing it for ten minutes in a saturated solution of common alum. It is then washed in cold water, is dried, and is given a second coating of sensitive gelatine made up as by formula No. 1.

The paper issued as "final support" for carbon printing by the Autotype Company may be used with this last formula. In the case of the paper that was issued some

years ago—but is, so far as the writer knows, no longer issued—no alum bath for hardening is needed, as the gelatine has already been rendered insoluble with chrome alum. With the more modern paper, coated with soluble gelatine only, the hardening bath is necessary.

No. 4

Paper coated with gelatine rendered insoluble with alum, as in the case of paper prepared by the last formula, is coated with the albumen solution given in formula No. 2.

The Negative.—It is to be observed that, in the case of the process that is at present under consideration, the negative does not need to be reversed, as in the case of most photo-mechanical processes. In fact, the absence of the necessity for a reversed negative, and the ease with which comparatively large work can be done, are the two chief advantages of the photo-lithographic process. The negative should have clear lines and considerable opacity in the rest of the film. All that is, farther on, said of line negatives for photo-zinco work applies to those for photo-lithography, except that the negatives do not need to be reversed, and that the extreme opacity needed in the case of the former processes is not needed in the latter. The consequence is that, whereas dry plate negatives are only barely applicable to photo-type work in line, nearly any brand of *slow* gelatino-bromide plates can be used to produce negatives for photo-lithography.

Exposure of the Sensitive Tissue.—The tissue is exposed in a printing-frame in the usual way. The image is quite visible, being of a brownish colour. Some prefer to judge the exposure by looking at the image from time to time, as in the case of silver printing, etc. Others prefer to use an actinometer, on account of the fact that there is always some danger of shifting of the paper through opening the frame, and because, in the case of line work, a minute amount of shifting, that would probably not even be noticed in the case of ordinary work, utterly spoils the

picture. In any case the necessary experience is learned with a little practice. Under exposure is shown by the fact that the ink washes off the lines, or, in the case of process No. 3, refuses to take on them,—over-exposure by the fact that the ink will not leave the clear spaces, or, in the case of No. 3 formula, takes on them in spite of all care. If the negative is too thin it is impossible to get a clear one, or other or both faults will appear whatever exposure is given.

Inking and Development of the Transfer.—The transfer paper is developed in a different manner according to the manner in which it is prepared. For either of the first two formulæ or the fourth it is necessary to cover the whole face of the paper with a thin film of transfer ink. The ink may be very carefully laid on with a soft sponge, the object always being to secure a very thin and even layer. The right thickness is indicated by the fact that the image is just visible through the ink, but is no more than visible. The best way in which to get an even coating is probably to ink up the smooth face of a stone or metal plate with a lithographic roller, to place the face of the sensitive transfer in contact with this, and to pass the stone or plate several times through the press, reversing the direction each time.

The next part of the process consists in the removal of the ink from those parts of the transfer which have not been acted on by light. To effect this, if formula No. 1 has been used, the transfer is floated, inked side upwards, on a bath of water heated to about 100° Fahr. After a time it will be seen that the surface stands in relief, the *lines* showing as depressions. The transfer is now removed, and is laid—still with the inked side upwards—on a stone or other convenient surface. Warm water is poured on to the surface, when, by the aid of very gentle sponging with a soft sponge or a pad of cotton wool, the ink will come away from all parts of the surface except those representing the lines. The application of the warm water is continued till all the gelatine is removed from the whole of the surface whence the ink has been washed. The sheet is

then very thoroughly washed in several changes of cold water, and is hung up to dry, when it is ready for application to the stone.

Some prefer to wash away the ink by the application of warm gum-water with a sponge, beginning to pour hot water on the surface only when the lines already stand clearly out.

If formula No. 2 or 4 have been used hot water is unnecessary, albumen being soluble in cold water. The process is just the same as that described, but cold, in place of hot, water is used. The paper is, that is to say, first floated, inked side upwards, on cold water, it is then laid on a stone, and the surface is washed by the aid of a sponge or a pad of cotton wool with cold water.

The proceeding in the case of formula No. 3 is different, the transfer being inked up in such a way that from the first the ink takes on the lines only. The name of Papyrotype has been given to this process.

After exposure, the transfer is immersed in cold water till it is quite soft. It is then squeegeed on to a lithographic stone or any other smooth surface, the edge next the operator being fixed to the surface by a little "cobbler's wax" or any other convenient cement, or it is laid on a sheet of glass or zinc, the edge next the operator being tucked under this so as to hold the paper securely.

A roller, which is either one covered with velvet or is of the composition of glue and treacle, or gelatine and glycerine, commonly used for making inking rollers for printing machines, is rolled on a slab, over which has been distributed very evenly an ink consisting of—

Best lithographic chalk ink	4 parts
Palm oil	1 pint ¹

The transfer is now carefully surface dried with blotting boards, and the roller is passed many times over it, working

¹ Abney's *Instructions in Photography*, p. 213. W. T. Wilkinson recommends the use of mutton fat rather than the more expensive palm oil. See his book *Photo-Engraving and Photo-Lithography*, as to the mixing of the ink.

always away from the operator so as to keep the paper stretched. The lines gradually blacken, whilst the ink, if everything goes as it should, does not take on the rest of the surface at all. If the finest lines refuse to ink up, a thinner ink may be used till they do. Whenever the design is quite distinct in all its parts, the process may be considered as complete, and the transfer is hung up to dry. When dry the whole surface is exposed to light to render it insoluble.

Transferring the Image to the Stone.—By whatever method the transfer is made, the image is transferred from it to the stone in the following manner :—

The preparation of the stone is a regular piece of ordinary lithographic work, which it is not proposed to describe here. It consists simply in obtaining a flat, polished surface by grinding, etc.

The stone being ready to receive the transfer, the paper bearing the image is damped from the back. This may be done by laying it face downwards on a sheet of clean paper, whilst a damp sponge is worked over the back, or by first very evenly damping a piece of stout printing paper, laying this on the back of the transfer, a sheet of zinc or other waterproof material on the top of all, and leaving them together for some time, or by placing the transfer for some time in what is known as a “damping book.” This being simply a pile of sheets of somewhat bibulous paper that are damped by interleaving with wet sheets and being left under pressure.

The stone is warmed either by placing it in front of a bright fire or by pouring hot water for some time on the face of it. In the latter case time must be allowed, after pouring the water on, for the heat of the stone to drive off the last of the surface moisture.

The stone is now placed on the bed of the machine, care being taken to so adjust it, if necessary, by packing paper between it and the bed, that its surface is quite parallel with the edge of the scraper, and with the line of motion of the machine; in other words, that the pressure of the scraper will be even over every part of it.

The damp transfer paper is now laid on the stone, great care being taken that it does not move after the two surfaces have first touched. The tympan is brought down, and the bed of the machine is travelled under the scraper several times, the pressure of the latter, on the back of the transfer paper, being increased at each stroke by bearing more strongly on the lever. The scraper is now turned end for end in its box, and the bed is travelled several times more under considerable pressure.

The back of the transfer paper is now liberally wetted with water, and after a little time it will be found that it can be removed, leaving the image on the stone. If *cold* water will not serve to render it removable, warm water may be used.

Inking up the Impression.—When the paper has been removed, the surface of the stone is wetted with gum-water applied with a sponge. The gum-water is simply a solution of gum-arabic in water, and is made by allowing the gum to soak for several days in cold water. The precise strength of the solution is not of great consequence; it is generally made up to a consistency something like that of olive oil. It should be filtered through cambric. The stone is now allowed to cool, and is left till the gum is dry.

The roller which is used for “inking up” in lithography is represented in the cut. It consists of a wooden roller, with tapered handles at each end, covered with flannel and over that with calf-skin. It is held by the two leather handles shown in the cut, which allow it to revolve freely if desired, but permit, also, of the application of a certain amount of *drag* by simply closing the hands on them.

To get the roller into condition for work, the leather is saturated with olive oil or some grease that will not dry out, and is then rolled occasionally for several days on a slab covered with lithographic varnish, the varnish, which adheres to the leather, being occasionally removed by scraping it off with a blunt knife. When a roller has to be laid on one side, after work, it is covered with tallow or lard, which is removed before work is begun again.

The gum-water being quite dry on the stone, what

remains on the surface is washed away with a damp cloth, the surface of the stone is evenly damped, and whilst it is damp, is inked up with ordinary lithographic ink, by passing the roller first over a slab on which such ink has been very evenly distributed, and then over the surface of the stone, which surface must be kept *quite* damp during this time.

Etching the Stone.—The etching is done with a very weak solution of nitric acid. No precise strength of solution can be given. It is commonly directed to make the mixture of nitric acid and water “about as strong as lemon juice,” but these directions can scarcely be considered as



very definite. The following test may, however, be applied:—A drop of the acid mixture is placed on the margin of the stone. If effervescence begins at once the acid is too strong. If there is no visible effervescence, even after some time, it is too weak. If a slight effervescence shows itself, after a few seconds, the strength may be considered as right.

The acid is spread over the face of the stone with a sponge, is left on it for a few seconds, and is then removed with a damp cloth. Gum-water is once more applied, allowed to rest on the stone for some time, is wiped off, and then the stone is ready to be printed from. This operation cannot be described in all its detail here. It consists in damping the stone, inking up the image with the roller, applying paper, generally slightly damped, bringing down the tympan, and travelling the bed so that the scraper is brought to bear on the back of the paper, and removing the now complete print. These operations go on continuously, gum-water being applied to the stone if it be desired to interrupt the printing for even a little time.

The inking of the stone is the part of the operation that needs most skill. To indicate the variations in result

producible by variation in manner of rolling and in the extent to which the ink is thinned with "varnish," I quote from the *Grammar of Lithography*, my chief reason for so doing being that what is said of inking a lithographic stone will, in some part at least, apply also to collotype printing to be hereafter described.

- "1. *Bearing heavily* on the roller 'feeds' the work more rapidly than bearing lightly on it.
- "2. *Light* pressure on the roller transfers but little ink to the stone, and also takes off some part of that which has been previously applied by heavy rolling.
- "3. *Slow* rolling produces similar results to heavy rolling.
- "4. *Quick* rolling produces similar effects to light rolling, consequently—
- "5. *Slow and heavy* rolling combined produce the maximum feeding effect upon the work; while
- "6. *Quick and light* rolling combined has the greatest effect in clearing an over-inked job and making the work look sharp.
- "A. *Too little ink* upon the roller will produce gray impressions under ordinary conditions of rolling.
- "B. *Too much ink* will, on the contrary, give smutty proofs.
- "C. *Thin ink* feeds the work very freely, and if too freely used will cause it to thicken and grow smutty.
- "D. *Strong ink* leaves the roller with difficulty and necessitates slow and laborious rolling."

Summing up—

- "*Slow heavy* rolling with *thin* ink will produce the maximum effect that can be obtained under similar conditions of temperature, and—
- "*Quick light* rolling with *strong* ink will have the greatest possible tendency to bring the ink away from the stone."

Photo-Zincography

The operations in zincography are very similar to those in lithography, a sheet of zinc from $\frac{1}{16}$ to $\frac{1}{8}$ inch in thickness being used in place of the stone, the surface being grained for direct writing or drawing, polished, as a rule, for transferring.

The transfer is laid down precisely as directed for stone, after which it is etched with the following solution :—

Decoction of nut-galls	$\frac{3}{4}$ pint
Solution of gum (thickness of cream)	$\frac{1}{4}$ „
Solution of phosphoric acid	3 drams

The nut-gall decoction is made by steeping 1 ounce of bruised nut-galls in 1 pint of water for twenty-four hours.

The solution of phosphoric acid is made by placing a number of sticks of phosphorus in a shallow bottle and pouring in water till the sticks are half immersed, corking the bottle with a cork having a notch down one side to admit a little air, and leaving the bottle to stand for several days. The water is then a weak solution of phosphoric acid, the thing needed. The same phosphorus may be used a number of times.

This etching fluid is applied in the same way as is the weak acid to the stone. It is washed off, and then the zinc plate is gummed in ; it is dried by the application of very gentle heat, or better, by fanning it till it is dry, and we proceed as follows :—

With a cloth moistened in turpentine, to each ounce of which a few drops of olive oil have been added, the surface of the plate is wiped till the image nearly disappears, care being taken to remove none of the gum.

The ink roller is now applied, when, the surface being dry, the whole of it will be blackened. Whenever it is evenly black water is sprinkled on it and the rolling is continued, when the image begins to be cleared out again, the ink being rapidly removed from all parts which have not been impressed with transfer ink.

Printing now goes on exactly as described in the case of a stone.

A lithographic transfer may be made by inking up the image on zinc got by the process just described (or by the bitumen process to be described hereafter) in transfer ink, and by transferring the image by the aid of common transfer paper to a stone. By so doing the slight amount of distortion that is almost unavoidable with the processes just described, due to the stretching of the paper, is entirely avoided, but it appears to the writer that it were better, when an etchable image is got on a zinc plate, that a photo-block be made by etching, as there is no doubt that a much more delicate image can be so got than by any modification of the photo-lithographic process.

CHAPTER XXXIX

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Collotype—General Principles

THE name Collotype is now almost universally used in this country, and Lichtdruck in Germany, to designate the process of printing in greasy ink from a surface of gelatine.

It has already been explained in the introductory chapters that if a film of bichromated gelatine be dried at a pretty high temperature, be exposed under a negative, be then washed in water and dried, it will, when treated in the same way as a lithographic stone, display similar properties,—will, that is to say, absorb water and refuse a greasy ink in certain places, whilst in others it refuses water, but subsequently takes ink.

The portions which take water and not ink are those which have not been affected by light, whilst those which take ink readily are those which have been greatly affected by light. Between these two extremes is a complete gradation represented in reality by a reticulation or grain, but giving the impression, so fine is this reticulation, of a true half-tone.

The close analogy between this process and that of lithography will be readily seen, and, in fact, it was in attempts to impress on lithographic stones images, which could be inked up like ordinary lithographic images, that collotype came first to be invented. Naturally one of the substances first applied to the surface of a stone in the attempt to transfer an image to it was bichromated gelatine,

and it was not for some considerable time that it was discovered that the *stone* in fact had nothing to do with the effect obtained further than inasmuch as it acted as a support for the gelatine film, and that other supports would do as well or better.

The difficulty found in all the first attempts at collotype, or, as it was then generally called, photo-lithography, arose from the reason that, after a few impressions had been taken, the film tore away from the support whether it were stone, a metal plate, or glass.

The first real advance was made by Tessie de Motey, who used a copper-plate, the trichromate of potassium in place of the bichromate and a reducing agent. The copper in these circumstances had the effect of rendering the portion of the film in direct contact with it quite insoluble, and therefore making the adhesion very complete.

This process has, so far as I am aware, become an affair of history only, having long passed out of use, but copper is still sometimes used as a support, amongst others by Mr. Ernest Edwards of Brooklyn, New York, and is, if I mistake not, increasing in popularity, the copper plates having the advantage over the glass plates now generally used of non-liability to breakage.

In general use, the process of Tessie de Motey was soon superseded by that of Albert, in which a plate of glass was coated with a film of bichromated gelatine. When the film was dry, the plate was laid face downwards on a black surface, such as a piece of velvet, and was exposed to light. The light acting through the glass formed an insoluble substratum which adhered very firmly to it and securely fixed to the plate a second coating of bichromated gelatine, to be afterwards exposed under a negative.

This process is still worked by some collotype printers ; but I believe that far the majority now use the process which is due to Husnick. In this process a plate of glass ground on one surface is used as the support, and a mixture of water, glass, and albumen is used on this ground surface as a substratum for the final film.

The principle adopted by Albert of exposure from the

back of the glass is still made use of to some extent at the present day with Husnick's process, as is also the discovery made long ago by Edwards, that the whole film might be acted on by alum to a certain extent, being thus toughened, and might yet be quite serviceable as a printing surface for greasy inks.

Preparation of Collotype Plates

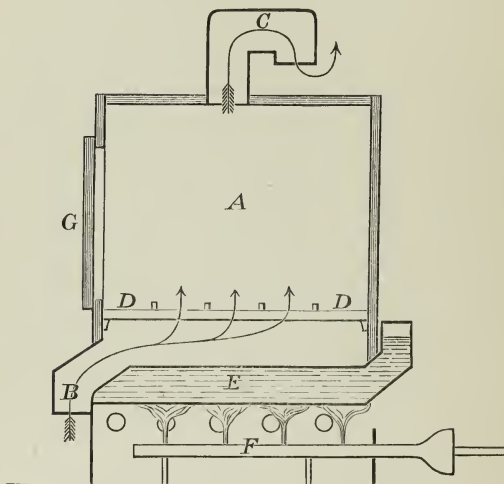
The chief requirement for the preparation of collotype plates is a suitable arrangement for drying the films. These have to be dried at a temperature of 120° to 140° Fahr., or sometimes even higher, in some place where there is a free admission of air. Some dry over an arrangement of two cast-iron plates between which water is kept boiling, a shallow boiler in fact, the upper surface of which is fitted with three projections forming a tripod to hold each plate in a level position, or better, with levelling screws consisting each of a small metal cylinder or plug with a screw fitting into it. The levelling screws can be moved bodily about, so that three will do for any size of plate, and each actual screw has a milled collar a little below its upper end, so that it may be screwed up or down. Others, again, use simply a somewhat thick cast-iron plate, on the lower side of which a row of regulatable Bunsen burners are allowed to play.

If this arrangement be used, it is necessary to take precautions against dust by covering the plates with a framework having muslin stretched over it, or by some such plan.

Although the arrangements just described have some undoubted advantages over the "oven" which is generally used, most prefer the latter arrangement, as the temperature may be adjusted to a nicety, whilst it is easy to guard against dust by stretching muslin over the air entrance passage.

There are many forms of drying box with various means of heating them. I illustrate one overleaf. A is the body of the box, with air inlet B, outlet C. D, D is a framework of iron with small projections carefully

levelled, so that plates when placed on these will assume a horizontal position, or, much better, with bar or angle-irons having levelling screws through them. The box is heated by a boiler E kept at the temperature necessary to heat the interior of the box to the desired degree by aid of the atmospheric burner F. A door G can be opened to place the plates in the box and to remove them. There must be a thermometer so arranged that, whilst the bulb is



inside the box the index is outside, and can at any rate be read from the outside.

Where work is done on a large scale the length of the oven, at right angles to the plane of the paper as shown in the sketch, may be made as great as need be to dry all the plates that it may be wished to dry at one time, but it is an advantage to have the oven divided into lengths by partitions, two or three plates only to be put into each of the departments so made, and then one as quickly after the other as possible. The reason for this is that, if, when a plate is partly dry, the door of the oven be opened to introduce another, a "drying mark" will very probably result on the first plate.

The Support

As has been said, either metal or glass may be used as a support for the collotype film. Glass is, however, now generally used, and this only will be treated here. The use of metal supports will be briefly treated farther on.

Glass Supports

With either of the processes to be described hereafter either polished or ground glass may be used. The former has certain advantages, as it does not give a grain peculiar to itself. A certain amount of grain is quite essential to the success of collotype work, but the whole of that grain, so far as possible, should be that due to the reticulation of the gelatine film, the grain in this case being of a "discriminating" type. When ground glass is used there is always a liability to a non-discriminating grain due to the glass itself. On the other hand, the adhesion of the film is much better with ground than with polished glass, and, as it is possible, by grinding very finely to keep the grain due to the glass so small that it is quite or almost imperceptible, the advantages seem to be in favour of ground glass. I shall, therefore, only treat of the use of this, merely saying that, if polished glass be used, it is necessary to clean it with the utmost care, preferably with a solution of bichromate of potash rendered acid with sulphuric acid, following the treatment with this by a thorough polishing with a mixture of alcohol or methylated spirit and ammonia. The thing to be avoided is the smallest trace of greasiness.

The glass should, for most purposes, be plate at least a quarter of an inch thick, and each sheet should be several inches larger each way than the size of the actual picture to be printed from it.

It is true that, for Husnick's process, to be presently described, fairly thick sheet glass *may* be used, and that a considerable economy will result to the beginner by making his first experiments with this. The liability to breakage,

however, much more than counterbalances the saving in cost that would arise from the use of such glass in practice.

The glass may be bought ready ground, or may be sent out to a glazier to be ground, but the advantage, in the matter of certainty that the glass, just as it comes from the grinding by himself, is chemically clean, are so great that it is far best for the collotype worker to grind his own glass. Moreover, the process is by no means difficult, and the trouble of sending out glass to be ground is very great, especially as glass has to be reground every time that it is to be used to support a film.

In grinding plate glass two plates are taken, a liberal amount of the finest emery powder made into a very thin paste with water is placed between them, and the one plate is worked over the other with a circular motion till the surfaces have been thoroughly de-polished. The emery paste is then washed away, a little more is put between the plates, and the operation is repeated, this time only for a minute or so. By this means a very fine ground surface is got.

To grind sheet glass in the way just indicated is a thing needing an immense amount of labour, as the surface of the glass is not even, and it is necessary actually to grind down all the elevations. The difficulty may be got over, however, by taking one sheet of glass only, and working the emery powder over it with a small piece of sheet tin which will "give" to the inequalities of the surface.

It is advisable to round off the edges of the ground surface. This may be done on a common grindstone, or better, on an emery wheel.

The Gelatine

The chemical substances used for the films of the plates are all well known to the photographer, and the only one that calls for any particular mention is the gelatine. It will readily be believed that on the quality of this depends, in a great measure, the success or the reverse of the pro-

cess. The qualities most desirable in a gelatine for collotype work are freedom from foreign bodies of any kind, and the property of withstanding long immersion in water, without either spontaneously becoming liquid, or absorbing a very great quantity of water. There are various gelatines in the market which are specially sold as suited to collotype work, and doubtless any of these got from a respectable dealer will serve the required purpose.

Albert, who must be heard with respect on all matters pertaining to collotype, has the following remarks on the choice of a gelatine for the particular work we are considering :¹—

Gelatines of excessive hardness and of excessive softness are both ill-suited to collotype work ; the soft gelatine giving a film which soon breaks up in printing, the hard gelatine giving a plate from which vigorous impressions cannot be obtained. He recommends the use of “middling hard gelatine,” and mentions a special brand, that of F. Creutz of Michaelstadt, Hesse, as particularly good.

He gives the following means of discovering whether a gelatine is suitable for collotype work as regards hardness : Two portions of it are made up, one with bichromate of potassium (either of the two formulæ to be presently given may be used), the other with bichromate of ammonium, substituted for the bichromate of potassium. Plates are coated with these solutions, and are dried at 120° Fahr. If they both show a polished surface, the gelatine is too hard. If they both show a mat surface, it is too soft ; if that prepared with bichromate of potassium show a mat surface, that with bichromate of ammonium a polished surface, the gelatine is of the right hardness.

It may be taken, then, that if a gelatine is free from foreign substances, if it shows a good result when the test just described is applied, and if it will bear soaking for forty-eight hours in water at a temperature of 60° Fahr., it is more or less suitable for collotype work, but even in the case of such gelatines there are great differences in the results.

¹ *Photographic News*, March 25, 1887, p. 185.

A collotype plate made with gelatine that is in all respects suitable except that it is unduly soft, gives an excellent vigorous picture, but tends to break up before many copies have been taken. A film made from a very hard gelatine stands excellently, but there is generally more or less difficulty in getting brilliant pictures from it, and, moreover, there is sometimes great difficulty in getting even films free from blemishes. This latter difficulty has been greatly lessened by improvements in the quality, as regards purity, that have recently been introduced in the manufacture of hard gelatines.

Nelson's No. 1 photographic and No. 2 photographic may be taken as typical gelatines. No. 1 is a gelatine of the highest purity, but is very soft. A plate prepared with it will give very brilliant pictures, but will not give a large number. No. 2 is much harder, and gives a film that stands well. With many subjects a brilliant image can be got from such a film, but for the majority of subjects a better result will be got by tempering the hardness of the No. 2 with a certain proportion of No. 1.

Most of the gelatines now made, especially for emulsion work, do well for collotype work, either alone or mixed with a certain proportion of a soft gelatine such as Nelson's No. 1.

The Negative

As in the case of every printing process whatever, the negative for collotype must be one having a full gradation of tone, and it may be said that it will always be possible to get good results from such a negative as is considered perfect for the production of a print on ordinary albumenised paper. On the whole, however, a negative rather thin for silver printing is the best for collotype. Such a negative as is suitable for solar enlarging, or for direct printing in gelatino-bromide or gelatino-citro-chloride paper is about the best.

Unless reversal of the final prints is permissible, it is necessary to have reversed negatives to print from. There are various ways of producing these. The first and best,

where it is possible, is to use a mirror or prism as a reflector in front of the lens of the camera. Another is to expose in the camera *through* the glass. It is unnecessary to say that if this expedient be had recourse to, the back of the plate must be cleaned very carefully. The method of reproducing by the powder or "dusting on" process, which produces a negative from a negative, but reversed as regards right and left, has already been mentioned. It is certainly one of the most practicable and beautiful of methods for producing reversed negatives.

I am aware that some photo-mechanical printers produce reversed negatives by taking advantage of the fact that a very long exposure produces, in the case of a dry plate, a reversed action of light, so that, giving a gelatino-bromide plate a very long exposure in contact with a negative, a negative is the result on development. I have seen excellent results produced in this way, but must confess that my own experiments have not been very successful.

A roundabout way in which to produce a reversed negative is to make, from the original negative, a transparency in the camera, turning the back of the negative towards the lens, and to make a negative by contact from a transparency.

When wet plates are used it is a comparatively easy matter to strip the film. The same gelatine solution as that to be presently described for dry plates may be used, but it is well to add one part of sugar to every three or four of gelatine to secure flexibility. The solution is spread on the plate exactly as to be described for dry plates, but it is only necessary to allow the gelatine to dry, when it may readily be stripped from the plate carrying the collodion film with it.

The stripping of gelatine films is a matter by no means so easy, but the writer has given considerable attention to the working out of a process for so doing, and ventures to say that if the instructions given be strictly attended to no difficulty will be met with. The following is the

description of the process as it was first published in the photographic journals :—

The process generally advocated is that of Plener, in which hydrofluoric acid is used to separate the film from the glass. Plener's method is so ingenious that one is sorry to pour any cold water on it ; but, apart from the use of hydrofluoric acid, which every one will avoid who possibly can, it would appear that the etching action of the acid on the glass has nothing to do with the stripping, inasmuch as almost any other acid will act as well as hydrofluoric acid.

This is not an observation made originally by myself, but was, if my memory does not fail me, made by Mr. W. B. Bolton. The action, whatever it is, is really the same as the "frilling" of a gelatino-bromide plate. Although almost any acid that is strong enough, or that has a strong enough action on gelatine, will serve to strip, it is, perhaps, scarcely correct to say that any other acid will do as well as hydrofluoric acid, inasmuch as I have found differences in the certainty in the action of different acids. After many experiments, I have adopted sulphuric acid as the most certain in its action of any acid, hydrofluoric acid included.

The difficulties that will generally be found in stripping are as follows : (1) The films refuse to strip at all. A process which will be quite successful with a negative freshly developed and fixed will often be found not to work at all with a negative that has been treated with alum, and is, say, a year old. (2) The stripping takes place between the new support and the film, instead of between the film and the glass. (3) The film after stripping stretches so that, not only is the negative to a larger scale than before—and with a corresponding increase of density—but probably there is likewise distortion, as it is highly improbable that a film will stretch exactly to the same extent in all directions. I saw a complaint of this stretching in one of the photographic journals only a few weeks ago. (4) The film is so hard and brittle when dry that it cannot be handled without danger of cracking it. And (5) the film twists or curls in drying, so that it is

impossible to get perfect contact between it and a flat surface, such as a collotype film. It has given me more trouble to ensure getting the film in a perfectly flat and flexible form than has anything else.

If the following directions be precisely carried out, it will be found that any negative, however old, may be stripped with certainty and without encountering any of the difficulties just enumerated. It need scarcely be mentioned that, if the negative has been varnished, the varnish must first be removed by the application of hot methylated spirits.

The following is made up :—

Hard gelatine	.	.	.	.	.	2 ounces
Water	.	.	.	.	.	10 „

The gelatine is, of course, soaked in the water till it is soft, when heat is applied. I can recommend Coignet's "Gold Label" gelatine. The solution should be heated to not very far short of the boiling point, and should then be filtered through flannel.

A negative to be stripped is warmed,¹ accurately levelled, and a certain amount of the gelatine solution is poured on the surface, and is guided with a glass rod till it covers the surface evenly. It is of great importance to measure the quantity, as the ultimate thickness of the film depends on this, and it has to be borne in mind that printing has, if the film is to be used as a reversed negative, to go on through the gelatine.

A quantity of 4 ounces per square foot will be found suitable for average work. This gives a film, when dry, of about a hundredth part of an inch thick. This sounds very thin, but, in fact, it is a good stout film. The film

¹ I assume here that the negative is one that has been treated originally with alum. If it has not been, it is necessary before the stripping process is begun to treat the negative with alum and allow it to dry, otherwise the hot gelatine solution will probably have the effect of destroying the negative by melting the film. It is particularly necessary to observe this in the case of negatives that have been developed with ferrous oxalate.

of an average gelatine dry plate, when dry, is only about one two-thousandth part of an inch thick. Still one-hundredth of an inch will not in the case of ordinary work cause any appreciable loss of definition in printing through the film. For very delicate work the amount of the gelatine solution may be reduced to 2 ounces per square foot. It is not advisable to use less than this, as otherwise the films will be too delicate for free handling. It is quite possible to flow as much as 10 ounces per square foot on glass without any special arrangement for preventing it from overflowing the edges; but a film of the thickness so got is, in my opinion, far too thick for any practical use.

If, however, such a film be wanted for anything, it will be necessary to give four times as long in each solution as is hereinafter directed, as it takes a long time for any liquid to penetrate a very thick film.

A saturated solution of chrome alum is taken, and there is added to it, drop by drop, liquid ammonia, till there is the slightest possible permanent flocculent precipitate. This is merely to neutralise any free acid that there may be, as any such free acid greatly impairs the setting powers of the alum solution.

The gelatine solution having set on the plates, the latter are placed for five minutes in the chrome alum solution. They are then removed and are washed till all the blue colour of the chrome alum has disappeared, when they are then placed in a bath of methylated spirits for about half an hour. They are taken from this, the surface is blotted with blotting-paper, and they go into a bath of—

Sulphuric acid	.	.	.	.	.	1 ounce
Water	.	.	.	.	.	2 pints

I use ordinary commercial sulphuric acid. I do not know the exact specific gravity of it, nor is it of much importance, as a considerable variation in the strength of the bath is permissible.

The following solution is now needed :—

Liquid ammonia	1 ounce
Glycerine	1 „
Water	2 pints

The films are left in the sulphuric acid bath till the greasiness caused by the alcohol disappears ; this will take about half an hour. At the end of that time it will be found that the corner of a film may be lifted, and that the whole will leave the glass with the greatest ease. The films go direct from the sulphuric acid bath to that of ammonia and glycerine. The object of the glycerine is to secure flexibility of the films, the object of the ammonia is to neutralise the sulphuric acid. It takes a long time to wash sulphuric acid out of a thick film, and if a long time be given in this case the film will stretch. The small amount of sulphate of ammonia produced in the film by the acid and the ammonia is quite harmless.

Glass is prepared by rubbing the surface with a solution of a few grains of bees'-wax in each ounce of benzine, and by polishing this away with powdered talc. A film is taken from the last solution as soon as it no longer tastes of acid—probably in about five minutes ; it is placed on a piece of glass, a pad of blotting-paper is placed on the back of it, and the squeegee is applied with great vigour. The plate supporting the film is then placed in a fairly warm place, so that the latter may dry ; but I find it almost always necessary, after a few hours have elapsed, to paste down the edges with narrow strips of paper and gum solution, otherwise they are sure to rise from the glass before the whole film is dry, and it will be found impossible to get flatness. An attempt must not be made to strip the film from the temporary glass support until it is perfectly dry. Then it is only necessary to insert the thin blade of a knife, when the film will come away in a form in which it is quite handleable, is beautifully flexible, and may be printed from either as a direct or a reversed negative.

It is to be observed that, if the film, before it goes into

the sulphuric acid, be dried spontaneously in place of by the aid of alcohol, the gelatine support will probably part from the film instead of the film parting from the glass.

The acid bath may, of course, be used for a long time ; in fact, as long as it acts. The ammonia and glycerine bath may be used as long as it continues to smell distinctly of ammonia.

I tried drying the stripped films on vulcanite, but found it impossible to prevent them from leaving the surface before they were dry, with the effect that they were hopelessly far from flat.

I fear that the process as I have described it reads as if it were very complicated. It is not really so. A negative may easily be stripped and be drying within two hours of the time of beginning operations, and quite a number may be done at the same time. The drying is the thing that takes longest. With films of average thickness it takes twenty-four hours.

The Exposure

Whatever of the several processes to be described is worked, the exposure is made in the same way, namely, by contact in a printing frame and to ordinary daylight. A common printing-frame may be used, although some prefer a frame with screws rather than springs as a greater pressure, and consequently better contact, may be had with the former than with the latter.

A visible image is formed. It is quite possible to so arrange a printing frame that the collotype plate, being fixed to the back of the frame, may be removed from time to time, the image being examined, but this is a plan not to be recommended. Where a glass support is used it is possible, with a little practice, to judge of the printing by examining the image from the back through the glass, only one-half of the back being in this case open at a time. Many workers prefer, however, to be guided in the matter of printing by the use of an actinometer, as in the case of carbon printing, and probably it is better to be so guided

than to trust to actual examination. The time taken in the printing-frame will not be greatly different from that needed for making an ordinary silver print. It makes no appreciable difference whether the printing goes on in full sunshine or in shade, except that the exposure is of course longer in the latter case than in the former. The margin of the plate is to be protected by an opaque mask.

CHAPTER XL

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Husnick's Collotype Process

I HAVE given the above name to the process of collotype, now most commonly worked, because I believe Husnick was the first to publish the distinguishing feature of it—namely, the use of a substratum of water-glass and albumen on a ground glass surface. If he was not the first actually to publish it, he was certainly the worker who had the chief influence in popularising it.

The Substratum

Albumen of fresh eggs	.	.	.	8 ounces
Commercial water-glass solution	.	.	.	3½ „
Water	.	.	.	10 „

The water-glass solution should be of the consistency of syrup. The three ingredients are mixed, and are switched into a froth either by the aid of an American egg-beater, or by placing the mixture in a bottle with pieces of broken glass and violently shaking the bottle. The froth is allowed to subside, at least partly, and the mixture is filtered through filtering paper. The fluid which passes through is preserved.

We will assume, in this case, that ground glass is used. If the glass be used immediately after grinding, no cleaning farther than copious rinsing with water is necessary,

as, after the emery and glass powders have been removed from the surface, the glass may be looked on as chemically clean. If it has been stored for some time after grinding, the surface must be carefully cleaned with a mixture of ammonia, methylated spirits or alcohol, and water. What is to be specially guarded against is the faintest trace of greasiness. Such will infallibly prevent that perfect adhesion of film to glass which is essential if more than a very few proofs are to be pulled.

The plates are coated with the substratum exactly as plates are coated with collodion in the case of the wet process. They are drained and are placed in racks to dry in any place where they are thoroughly protected from dust. Each plate is then well rinsed under a stream of water to remove any soluble matter that there is, and is once again dried. There should remain a barely visible film on the surface of the glass.

The Sensitising Solution

Nelson's No. 1 gelatine	. . .	1 ounce
Nelson's No. 2 gelatine	. . .	1 „
Bichromate of potassium (dissolved in 2 ounces of water, and reduced to double chromate of ammonium and potassium by the addition of ammonia as already described for carbon print- ing)		100 grains
Alcohol or methylated spirits	. .	1 ounce
Chrome alum		2 grains
Water		20 ounces

The gelatine is allowed to soak in the water till it is soft, and is then dissolved by the aid of heat. The bichromate—or rather double chromate—is then added, and afterwards the chrome alum in the form of 40 minims of a 5 per cent solution. The use of the alcohol is merely to improve the flowing properties of the solution. It should be added only immediately before the use of the mixture for coating glass. The mixture may be used fresh, but,

without the addition of alcohol, it will keep for a long time, and many consider that better results are got if it is at least a day or two old. It does not keep well, however, when alcohol forms one of the constituents. Hence the advice to add the alcohol—which may be omitted altogether—only when the solution is to be used immediately.

The solution is to be filtered. Calico, or swan's common calico, or better, "swan's-down calico," may be used for this purpose, but the best medium is probably chamoisleather. This must be first thoroughly washed in a strong soda solution, and afterwards in clean warm (not hot) water. The solution should not be raised to any temperature higher than about 140° Fahr. 120° is better.

A plate to be coated is heated to about the greatest temperature that the hand can bear. It is then taken in the left hand, and is balanced on the tips of the finger and thumb; a card mount being placed under it if it be found too hot for handling.

A pool of the hot solution is now poured on the upper surface—that with the substratum, of course—and the plate is quickly tipped, so that some of the solution is poured off at each corner. The plate is now rocked slightly so as to cause the liquid to spread itself in a perfectly even film, and is immediately placed in the drying box.

It is impossible to say precisely how much solution should be left on the plate; but it may be said that if the thickness of the film be right, the drying, at a temperature of 120° to 140° Fahr. with a good supply of air, will take from one to three hours.

The plates, whenever they are dry and have been allowed time to cool, are ready for printing, although some prefer to keep them for a day or two in a cool dry place, protected of course from light. It may be well to state here that, although a collotype plate is little, if at all, more sensitive to light than a sheet of sensitised albumenised paper, an amount of stray light that would do no harm to the latter may ruin the former. This is, partly at least, due to the "continuating action of light" which takes place

in the case of collotype plates as in the case of carbon tissue. This refers only to the time after the plate has been dried, and before it is developed. During this time it should be carefully guarded from white light. When it is wet it is comparatively insensitive, and after development, if that process has been thoroughly carried out, it is no longer sensitive at all.

The exposure has been already described, but after the main exposure it is customary to give a supplementary exposure through the back of the plate. There is a two-fold object in this supplementary exposure. One is to further increase the adhesion of the film to the glass, the other is to prevent the excessive swelling of the gelatine film during drying, such swelling greatly interfering with the pulling of sharp proofs. The exposure may be made either by removing the plate from the frame and laying it face downwards on a piece of black velvet, or by leaving it in contact with the negative, merely removing the back of the frame, care being taken in the latter case that the position of the plate in relation to the negative is not allowed to change.

The duration of this exposure will vary with the nature of the negative from which the print has been taken. If this is as thin as will make a satisfactory collotype plate the exposure from the back may be entirely dispensed with. If the negative be one showing strong contrasts, and tending to give heavy shadows, it may be several minutes in the brightest diffused light. Nothing but experience will teach how long this exposure should be. It may serve as a rough guide to say that it should seldom be longer than will allow a piece of sensitised albumenised paper to turn of a deep chocolate colour. The thicker the film the longer should the exposure be.

Development of the Plate

The plate is developed merely in cold water. Whenever it is placed in the water, a curious change takes place—the image shows in a certain relief, the high lights

swelling up, at the same time the whole of the film, except those parts representing the deepest shadows, develops a fine grain of the nature of a *reticulation*. This grain should be so fine that it is barely visible to the naked eye.

The development is continued by washing the plate with continuous changes of water till the last trace of bi-chromate is washed from the film, as indicated by the complete absence of colour in the washing water. The image will now be all but invisible, but by reflected light showing merely as a "ground-glass"-like picture; the image by transmitted light being of a very faint brown colour.

It will be observed that the use of a small quantity of chrome alum is recommended in the sensitising solution. This is often omitted. When it is, it is advisable to soak the plate for some time after development in a 1 per cent solution of common alum. The result of such soaking is not only to harden the film, but also to remove any trace of chromate that may have remained in the gelatine even after long washing. Even when the small quantity of chrome alum mentioned above is used, it is sometimes advisable to use the alum bath, and especially where a soft gelatine has been used. If the alum bath be used the plate must have a second washing. It is then dried, when, if it be wanted immediately, it is ready for use. It is well, however, when possible, to let the plate stay on one side dry for two or three days before printing. It will probably last longer in the press if so treated. Drying may be much expedited by soaking the plate for five minutes in a bath of methylated spirits, and surface-blotting the film with blotting or filter paper.

CHAPTER XLI

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Albert's Collotype ("Albert-type")

THE above name has been given to Albert's process. It differs from that of Husnick only in the nature of the substratum used. The substratum used by Albert is bichromated gelatine. It is more troublesome to apply than the simple substratum of Husnick, but it causes more complete adhesion, and a greater number of prints may generally be pulled from an Albert plate than from a Husnick. The Albert process is particularly well suited for producing plates for machine work.

As in the case of the process just described, very finely-ground glass plates, which should be fairly thick, are used.

The substratum is made up as follows :—

Nelson's X opaque gelatine	1 ounce
Water	10 ounces
Albumen	10 „
Bichromate of potassium (converted to double chromate of potassium and ammonium by the addition of am- monia as already described in the case of the carbon process)	200 grains

The gelatine is soaked in the water, and is then melted by the aid of heat. The albumen is then added, and the whole is churned up together with an American beater.

Care must be taken not to make the solution too hot lest the albumen coagulate. The bichromate is finally added having been dissolved in about three ounces of warm water, and converted with ammonia as already described. The solution is then filtered, when it may be used for coating the plates.

A plate to be coated is warmed, and is coated by holding it level in the left hand whilst the solution is poured on it from a vessel in the right hand. By no means must the excess of solution be drained from the plate, as a pretty thick coating is advisable. The plate is rocked till the coating appears quite even, when it is laid on a levelling table in a cool place. The gelatine soon sets, after which the film is allowed to dry at the ordinary temperature of a room, or in a room only moderately heated, being reared on edge if it be considered convenient.

The plate once dry is laid face downwards on a sheet of white paper, and the film is exposed—through the glass of course—till a distinct change is seen in the colour. It is generally recommended to use black velvet in place of white paper, the idea being that the velvet absorbs the light and prevents the surface of the film from being rendered insoluble—a thing that is not desirable. There is, however, no appreciable difference in this particular, whether a white or a black surface is used, unless the film is far too thin, and the white surface makes it possible to watch the change of colour very easily. It will be well to coat a few small plates of common glass with the composition as well as those actually to be used, and to expose the former first so as to learn what, exactly, amount of exposure should be given to the actual collotype plates. This may be done in the following manner :—A small plate is exposed from the back till a distinct change in colour is visible. It is then washed in running water till most of the soluble chromate is washed out, when it is placed in water of about 140° Fahr. If now a small quantity of the gelatinous surface washes away, leaving, however, the greater part of the thickness adhering to the glass, the exposure has been right. If none of the film washes away it has been too

long; if the whole, or nearly the whole, washes off, the exposure has been too short.

When the correct exposure has been determined in the way that I have just described, the actual plates to be used may be exposed and washed, first with cold water and then with hot water, exactly as described for the trial plates. They are then to be coated with the sensitising solution. The solution recommended for the Husnick process will be found quite suitable for the Albert process also, but it will probably be found best to omit the alcohol, as an alcoholic solution poured on a gelatinous film that has absorbed water tends to run in streaks.

The coating and drying and development are done exactly as for Husnick's process, but that no further exposure from the back is needed, although a short one is considered an advantage by some, especially when the second coating has been somewhat thick. If the plates have been very thoroughly washed after they have received the substratum, they may be kept for a considerable time before they are treated with the sensitising solution, but it is generally considered best to use them as soon as possible.

On the Use of Metal Plates as a Support for Collotype Films

Metal plates offer some advantages over glass plates for the support of a collotype film, the greatest of which, probably, is their non-liability to breakage. Moreover, no substratum is needed with a metal plate. Probably the only objection that there is to them is that it is more difficult at first, at least, to tell from the appearance after coating whether or not the film is of even thickness—a thing that can be very easily told in the case of a film on glass by merely looking through it. It may be well here to state that evenness of film is essential to success in collotype work.

The two metals that are most commonly used are zinc and copper, although it is probable that other metals, such as pewter and type-metal, might do as well. It is only

necessary to grain the plate so as to secure adhesion of the film, to coat with the sensitive solution, dry in the drying box, expose and develop as in the case of films on a support of glass, when the plates are ready to be printed from.

If zinc is used it will be found most convenient to grain it by placing it in a solution of nitric acid; if copper be used it will be found most convenient to grain by the use of emery powder.

If zinc is used the thickness and quality made for photo-type blocks are to be recommended; if copper be used the plate sold for photo-engraving will be found to be in every way suitable.

Whichever kind of plate is used, it must be first polished. This is done by laying it on a flat board with a couple of tacks driven into the board at each end of the plate, and with the heads not rising higher than the edge of the upper surface to prevent it from moving. The polishing is done with emery paper wrapped round an "emery stick," which is simply a piece of wood about 16 inches long, cut to the form—a form approaching what is known as a "parallel flat file." That is to say, it is cut of a rectangular section, measuring perhaps $1\frac{1}{2}$ inch wide by $\frac{3}{8}$ inch thick, the edges being slightly rounded. To use the "stick" a sheet of "medium" emery paper is wrapped round it, and the stick is drawn and pushed backwards and forwards on the surface of the plate, always from end to end. When the "emery stick" is used for polishing iron, oil assists the process so materially that it is generally considered essential. Copper and zinc may, on the other hand, be polished dry, but the process goes on more satisfactorily if the surface of the plate is kept damp with turpentine. When the medium emery has produced all the effect that it apparently will produce, the polishing is finished with the finest emery paper.

If oil have been used the surface must be thoroughly cleaned with soap, soda, or potash and water. The grain-ing may then be done by "mulling," as it is sometimes rather improperly called, with emery powder and a piece

of plate glass of a couple of inches square or so—that is to say, by covering the surface of the metal with a paste of fine emery powder and water, and working this by a circular motion of the piece of glass.

As has been said, where zinc is used, an acid bath is recommended for giving the grain. This may be made up as follows :—

Nitric acid	1 part
Saturated solution of common alum .	5 parts
Water	100 „

This is poured over the clean surface of the zinc plate and placed in a dish, and is kept moving over it by rocking the dish for from two to five minutes, the action being stopped when the whole surface appears of an even pearly gray colour.

As has been said, no substratum is needed, and coating with the sensitive solution, drying, exposure, and development go on exactly as for Husnick's process, except that there is, of course, no exposure from the back of the plate.

CHAPTER XLII

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

The Heliotype Process

THE process to which the above name has been given will be understood by the aid of a very brief description if the process of Husnick be first mastered. Heliotype differs from other collotype processes, in that the sensitive film before exposure is separated from the glass on which it is prepared, is manipulated as a film, and is then cemented down to a pewter plate for development and printing.

The first requirements for heliotype work are plates of glass allowing 2 inches at least of margin beyond the proposed size of picture, and polished pewter plates of the same size, or somewhat larger, and about $\frac{1}{8}$ inch thick. The glass should be British plate, and must be finely ground on one side in the manner already described for collotype work. The surface has then to be covered with a film of wax of the extremest possible thinness. To effect this a 1 per cent solution of pure bees'-wax in pure benzine is made, and the waxed side of the glass is flooded with this. A flannel cloth is then dipped in French chalk, and is used to polish off the wax that remains on the glass after the benzine has evaporated, the polishing being continued till there is no further appearance of wax. Finally, a brief polishing is given with a perfectly clean and dry cloth. To reduce the chance of refusal of the skin to leave the glass it is well to perform this operation two or three times the first time that the skin is to be used. If there is no ad-

hesion at first one polishing is ample afterwards. Indeed, even one is by no means quite necessary, as two or three skins may often be stripped from a sheet of glass without intermediate polishing, and without showing any tendency to stick. It is well, however, to make it a rule to polish before each application of the gelatine solution.

The gelatine solution may be made up as follows:—For each square foot of glass that is to be coated we take the following:—

Nelson's X opaque gelatine	.	.	.	1 ounce
Glycerine	.	.	.	1 dram
Bichromate of potassium	.	.	.	48 grains
Chrome alum (dissolved in $\frac{1}{4}$ ounce water	.	.	.	6 „
Water	.	.	.	6 ounces

The gelatine is soaked in the water till it is soft. It is then melted by the aid of heat, the glycerine, the bichromate of potassium (in the form of a fine powder), and the chrome alum are added with much stirring. The solution is then filtered, as has already been several times described for gelatine solutions. It is then ready for use, but may be kept for some time if it be considered desirable.

A plate to be coated is warmed to about 120° Fahr., and is carefully levelled. The solution in the quantity mentioned above is then poured in a large pool in the centre of it, and is caused to flow to the corners and edges by the aid of a glass rod, the plate being very slightly tipped if necessary. No excess is poured off, but the plate is allowed to cool till the gelatine has set, any air-bubbles that may have formed being in the meantime either coaxed to the edge or broken with the glass rod.

When the gelatine has set the plate is carried to the drying box, where it is placed in a horizontal position. The temperature of drying for heliotype skins is much lower than for collotype plates, and the time taken is much longer. The temperature should never fall below 75° Fahr., nor rise above 80° Fahr.—that is to say, it should be kept at just a little below the actual melting point of the gelatine solution. The success of the process mainly depends on

the uniformness of the temperature. The box must be of a nature to allow a good current of air. The time taken for drying will not be much short of two days.

When the plate film is thoroughly dry the plate is removed from the drying box, and the point of a knife being inserted between the film and the glass, the former is stripped away. It is then ready for exposure.

The exposure of the film is a very simple matter. As it is flexible it may be printed in an ordinary printing-frame, and the image may be examined at any time. The exposure is complete when all the detail is visible. It should be mentioned that the side that was in contact with the glass during drying is to be brought into contact with the film of the negative during printing. All margin beyond what is actually to print must be protected by an opaque mask.

After the exposure under the negative is finished the back of the film must be exposed till the action of the light has just penetrated to the opposite surface. Some prefer to give the exposure before that in the printing-frame, some after. There appears to be no difference in effect whether the exposure of the back of the skin is made before or after that in the printing-frame.

To regulate the exposure from the back so that the action of light will just pass through the film, we take a small strip cut from the edge of the skin, double it one half over the other, and place over it a piece of black paper, or any other opaque substance, with a small hole in it, exposing this along with the film, which latter is placed face downwards on a piece of black velvet with a sheet of plate glass on the top to keep it flat. The exposure is continued till the effect of the light has just penetrated through the first fold of the strip of skin and has made the least possible image of the whole on the second. It will be evident to any photographer how a quarter-plate printing-frame may be utilised for holding the doubled strip of skin and the piece of opaque paper with the hole in it.

This second exposure over, the film has to be fixed to a

pewter plate. This is done in the following way. The plate is coated with a solution of rubber in benzine, of about the consistency of thin cream, by flowing and draining it as in coating a plate with collodion. Time is then allowed for the rubber to set, when the pewter plate is laid, rubber film side upwards, in a dish of water, the back of the skin is brought into contact under water with the rubber, the plate and skin are quickly lifted out together, and a squeegee is vigorously applied to the skin to bring it into thorough contact with the plate, and to expel any air-bubbles that may be imprisoned between the two.

The two having properly adhered, the plate with skin attached must be immersed in water till the excess of bichromate has been washed out. It is then ready to be placed in the printing-press. A sheet of clean paper is placed on the face of it, and the platen is brought down with the greatest possible force, and is kept down for two or three minutes. The object in doing this is to reduce the excessive relief, or, as is technically said, to "smash down" the high lights.

The operation of heliotype printing does not differ in any material way from that of collotype printing.

CHAPTER XLIII

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Printing from Collotype Plates or Skins

To *teach* collotypic printing to one quite unpractised in that or any analogous descriptions of printing merely by giving instructions is a thing that is quite impossible. A skilled lithographic printer, if the manipulations of collotype printing be described to him, will very soon master the more delicate process; the operator who is ignorant altogether of printing can expect to become expert only by long practice. His labours will certainly be greatly facilitated if he can get a printer already skilled in working collotype to help him.

The best description of the process of collotype printing that I know is to be found in Wilkinson's excellent little book on photo-mechanical printing.¹ It is very complete, but is longer than the scope of this work permits. The reader is referred to the book just mentioned for much useful information on collotype and other allied work.

The principles involved in collotype printing are the same as those in lithographic printing, but the process is in every way more delicate than the ordinary run of lithographic work.

The ordinary lithographic press may be used for collotype printing; but presses are made specially for the latter process which are better suited than lithographic presses

¹ *Photo-Engraving and Photography*, by W. T. Wilkinson. London: England Brothers, 25 Charles Street, Notting Hill, W.

for the special work for which they are designed. The pressure is applied vertically to the surface of the plate by a platen or a cylinder, instead of by a scraper, which has a tendency to drag the film off a collotype plate.

The following is a very brief description of the process of printing :—

There is no gumming or etching in collotype printing as in lithography. The plate is simply damped, inked, and passed through the press; but in damping it is a common practice to add to the water some deliquescent substances, which prevent evaporation and make it necessary to damp the plate again till several prints have been pulled. This treatment with water and deliquescent substances is commonly termed *etching*, although the name is really a misnomer.

A quantity of this “etching fluid” may be made up as follows :—

Water	.	.	.	.	.	.	12 ounces
Glycerine	.	.	.	.	.	.	1 pint
Common salt	.	.	.	.	.	.	30 grains

Or two parts of water may simply be mixed with one part of glycerine.

The plate is left for two hours in this solution, is surface-dried with blotting-paper, and is fixed to the bed of the press. If it be left wet on the under side, it will often fix itself with sufficient strength without further cement of any kind, but it is common to fix it down with plaster of Paris.

The outer edge of the plate is protected with a mask of oiled paper, so arranged that it can be lifted away before inking and be replaced afterwards. This is to secure perfect whiteness of the margins.

It is quite possible to do collotype work with lithographic ink, thinning as may be needed with varnish. Collotype ink is, however, now an article of commerce, and it will be found to give far finer results than lithographic ink. Collotype ink is, according to Wilkinson, ground up with lard or fat instead of varnish, and I can

state that my friend K. Ogawa has, in the absence of the commercial article, made excellent black collotype ink by incorporating, with a muller on a stone, the best quality of Japanese lampblack—which is of a very high quality indeed—with lard. The photographic brown or purple, or any other desired tint, may be made up by adding different colours to the ink. A plate may be inked up with either one or two inks. Where the subject is one in which there is not much half tone—where the whole picture tends towards one or other of only two tones—or in fact for all rough work, one inking will give quite satisfactory results, but, where there is a long range of half tone, it is generally found that the best results are to be had with two inkings. In this case the ink that is to be used second is to be made thinner than that used first, and, if the colour be other than black, it is usual to make the tint lighter as well as to make the ink thinner. That is to say, there is a larger proportion of the tint mixed with the thinner ink. In fact, good results are often got by using a pure black ink first and a tinted ink afterwards.

The ink is always applied by rollers, and there is a good deal of difference of opinion as to what is the best kind of roller to use. Rollers are either of leather—as for lithography, a best quality lithographic roller being, in fact, what is used—or of the glue and treacle composition so much used by printers, of rubber or of felt. The first two are the most commonly used; the rubber roller is well spoken of by many, but I have no experience of its qualities. The felt roller is, I believe, but little used except for damping, as to be hereafter described.

It is probable that the leather roller would be the favourite with all were it not for the trouble necessary to get it into working order at first, and the incessant care necessary to keep it up to the mark. The method of getting a lithographic roller into condition and of preserving it have already been briefly described in the chapter on photo-lithography. The necessity for this treatment makes the use of the leather roller almost out of the question for amateur work.

Composition rollers may be purchased ready made. The best quality only should be used. There is a very full description of the way in which they may be made in Wilkinson's book already referred to. A composition roller before it is used should have the surface somewhat hardened by filling a flat dish to a depth of $\frac{1}{4}$ inch or so, with a 1 per cent solution of tannin in methylated spirits or alcohol, and rolling the roller backwards and forwards in this for a minute or so.¹

When two inks are to be used some use a leather roller for the first ink, a composition roller for the second.

A slab, or if there are to be two inkings two slabs, must be supplied for spreading the ink on. Lithographic stones may be used, or thick sheets of plate glass, which may with advantage have the surface ground.

First supposing that one inking only is to be given, a thin layer is spread on one of the slabs by taking a small quantity of collotype ink, and reducing it to a condition in which it can be readily worked by incorporating lard with it by the aid of a palette knife, by placing a few dabs of this composition on the roller and persistently rolling across and across the slab, first in one direction, then in a direction at right angles to the first, till an even black or dark tint results.

The wet collotype plate has, it is assumed, been placed on the bed of the press. The excess of the moisture is removed by wiping the surface with a very soft damp cloth. The roller is now applied with considerable pressure and with a slow motion across the surface of the plate to and from the operator. The ink should take readily, and the surface should, indeed, nearly blacken all over, the high lights being at least considerably veiled. The pressure is now decreased whilst the speed of the motion is increased. This has the effect of cleaning out the high lights and half-tones, and a point will be reached where the image appears right against the white background of plaster of Paris or against the metal plate. The inking is stopped at this stage, the mask is lowered so as to protect the

¹ Burbank.

margins of the plate, and at the back, a piece of damp paper is placed over the plate and mask, with a piece of soft felt behind all, and the tympan is now lowered, the bed is travelled, and the pressure is applied. The paper is at once ready to be removed from the surface of the plate, and it will come away carrying the image with it.

This process goes on, the plate being damped with water in a soft sponge after every impression has been taken, or with the etching fluid above mentioned after every half-dozen or so of proofs have been pulled, the excess of moisture being, in either case, removed with the soft cloth as already described.

Almost any kind of paper may be used, but that most suited to fine work is what is known as "mat enamel paper." As has been said, the paper should be damped. This is done by thoroughly wetting half of the sheets that are to be printed from, and by piling alternate wet and dry sheets, then laying a weight on the top of the pile and leaving the whole at least for an hour or two.

When there are to be two inkings the first ink is made up very thick. There is added to it only as much lard as will make it possible with a considerable amount of labour to spread it evenly on the stone. The second ink is made a good deal thinner. If the plate have been properly exposed, and the ink have been properly mixed, it will be found that only the deepest shadows will take it at all readily. When these have taken the ink, but without waiting till they get excessively dark, the thinner ink is applied to work in the details and the shades of the high lights.

The beginner need not be disappointed if the first few prints are far from being up to the mark. Even in the case of an experienced worker, the first few prints are generally much inferior to the best that the plate is capable of producing.

It must always be borne in mind that an indefinite number of prints cannot be expected from one collotype plate. There are, it is true, exceptional cases when the

weather is cool, and when all other circumstances are favourable, when thousands of copies may be pulled from one plate; but in average circumstances only a few hundreds can be expected, and there must be no disappointment if the film break down after a few dozen prints have been produced.

Taking these circumstances into consideration it is desirable to make, in the first place, a number of collotype plates if a very large number of prints be desired.

The prints are varnished or are left unvarnished according to the taste of the public for whom they are produced. Husnick recommends a varnish consisting of one part of gum-mastic and two parts of shellac dissolved in alcohol. Frequently a water varnish, made by dissolving shellac in a hot solution of borax, is used.

Printing by Machine

Concerning machine printing of collotype it is unnecessary to do more here than state that machines are now commercially produced for the purpose of collotype printing, capable of turning out several thousand impressions in a day, and that these machines in skilled hands give excellent results, the plates, according to Mr. E. Edwards, lasting better under them than under hand-presses.

CHAPTER XLIV

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Defects in Collotype Prints, their Causes and Remedies

THIS is a subject that must be treated here with the utmost brevity.

The Print is too Black.—This is generally due to over-exposure of the plate or skin. It may, however, be due to the use of too thin an ink. Not, that is to say, one deficient in colouring matter, but one too nearly liquid. If the use of a thicker ink do not improve matters, the film should be cleaned of ink and should be treated with dilute ammonia—say 5 per cent mixture—to soften it. This will be effectual if the exposure have been only a little too long.

The Print is too Light, lacking Vigour.—This fault will, of course, arise from the use of an excessively thin negative, but supposing the negative not at fault, it generally arises from under-exposure. In this case the cause is readily recognised, as the shadows clog up before the detail in the high lights can be got to take ink. In this case there is no remedy. There is another case, in which the whole of the gradation appears, but in which there is still lack of contrast or sparkle. This may arise from the use of certain gelatines, from drying at too low a temperature, or from too thin a coating of the plate. Good results may sometimes be got in such cases by the use of a thin ink highly coloured with colouring matter. This may be prepared by thinning collotype ink with a very

little olive oil, or a mixture of olive oil and lard, according to the concentration of the colour that is considered necessary.

Unevenness of the Impression.—This is almost always due to uneven coating of the plate. There is no cure for it. It is essential that the plate be evenly coated.

The Prints are Vigorous, but the Grain is so pronounced as to interfere with the Delicacy of the Result.—This is generally due to the use of too thick a film, or to too high a temperature in the drying-box. The means of avoiding the defect are evident.

Spots are generally due to either air-bubbles or dust in the film, or to the use of an unsuitable gelatine.

General Dirtiness of the Image (as distinguished from want of contrast, as described above), is generally due to insufficient damping of the film.

CHAPTER XLV

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Etching Transfers on Zinc to Produce Relief Blocks

General Principles.—When prints are pulled from stones or plates in the way already described, the principle involved is quite different from that involved in pulling a print from type or from a wood block. In these latter cases the portions of the surface which are to print dark are raised above the others in place of being on the same level, and differing only in their power of attracting a greasy ink.

The advantage of blocks with raised surfaces is that they may be “set up” with type and may be printed at the same time, whereas impressions from stone or zinc must be taken by a separate process.

If it be considered that the ink which is transferred to a zinc plate, as described in Chapter XXXVIII., is of a greasy nature and has the property of repelling all or almost all aqueous solutions, whilst the rest of the surface of the zinc has not, and if it be borne in mind that certain of these solutions—as, for example, nitric acid—have the property of dissolving away zinc whenever they come in contact with it, it will be seen that by simply placing a zinc plate in such a solution we should have a ready means of producing a relief block, the solution eating away those parts of the surface not protected by fatty ink, leaving those protected in relief.

Unfortunately the process in practice is not quite so

simple as that just indicated, and this for two reasons. The fatty ink image, unless intensified in some way, has barely power of resistance sufficient to prevent the acid used from penetrating it to a slight extent, and making the lines porous or "rotten," and, moreover, the action of the acid is unfortunately not only vertical but also lateral, inclining to undermine and eat away the lines. The great difficulty in etching lies really in contriving, by various means, to prevent or counteract this lateral action of the etching fluid. The following is a fairly complete account of one of several methods of etching which differ a little from each other :—

Materials for Etching

Besides all that is necessary to produce a transfer on a zinc surface as already described, the following are needed for etching :—Sundry dishes much larger than the plates to be etched, which may be of white stoneware or other acid-resisting material for work on a small scale, but are generally of wool lined with pitch for large work, several broad, flat camel's-hair brushes for brushing the bubbles from the surface of the plates, finely-powdered resin or colophony, and finely-powdered asphalt, also a special smooth or polished inking roller, made by rolling the ordinary leather roller in ink made up of lithographic varnish and red lead, allowing to dry, rubbing down with fine cabinet paper, and repeating the operation as often as may be necessary to get a fine polished surface. This roller may very easily be cleaned from ink at any time with a little turpentine.

Three baths of different strengths are commonly used in etching, and these strengths are generally made up by working to specific gravity, as commercial nitric acid is itself a substance of not very definite strength. The Baumé hydrometer is usually employed for taking strengths. For average work the three baths may be made up as follows :—

No. 1 bath	2° Baumé at 65° Fahr.
No. 2 bath	10° " " "
No. 3 or deep etching bath	18° " " "

These strengths are approximate only. Thus for very fine work it may be necessary to begin with a bath weaker even than No. 1, whilst for rough work a stronger bath may be used even at once. Again, the baths quickly lose strength if in continual use. For this reason the first bath has, after a time, to be rejected, bath No. 2, generally considerably diluted, takes its place, bath No. 3 takes the place of bath No. 2, and a fresh "deep etching bath" is made up.

Many experienced workers do not make up the baths with the hydrometer at all, but trust to the knowledge that they have gained by experience to enable them to make up to, and keep at, the right strengths, judging by the effect that the acid has on the zinc.

The strength of the first bath is the most important. If, immediately that a piece of polished zinc is placed in the liquid, the surface becomes covered with minute bubbles, it is proof that the bath is too strong. If no action at all is visible after a minute or so, it is too weak. All that can be said of the other baths is that the second may be considerably stronger than the first, the third considerably stronger than the second.

The dishes or "etching boxes" must be so arranged that a rocking motion can readily be given to them.

A transfer is impressed on the surface of a polished zinc plate as already described, Chapter XXXVIII., p. 301, great care being taken to have the lines very perfect, and to ink them up with as much ink as they will stand without danger of spreading.

The inking up may be done either in the way described in the chapter already mentioned, or in the following manner.

The image having been transferred to the zinc plate is gummed up with a plentiful supply of the decoction of gum, nut-galls, and phosphoric acid, already described in the chapter just referred to. The gum is then dried by fanning at a moderate temperature. The surface is now once more damped, using by preference rather thin gum solution. When it is quite damp, but not wet, the image

is rolled, inked up with a lithographic roller repeatedly charged with ink, the surface being re-damped whenever the ink shows a tendency to take on any part of the surface not representing a line. When the image will take no more the gum solution is washed away, when the plate is ready to undergo the process immediately preliminary to etching.

There is now dusted over the plate with a dry camel's-hair brush finely powdered asphalt. This adheres to the lines. The dusting process is continued for about one minute, by which time the ink is saturated with asphalt. The powder which rests on the other parts of the surface is carefully dusted away with the brush and with cotton-wool. The plate is now gently heated till the brown colour of the asphalt powder changes to a black, indicating that it has melted and become incorporated with the ink. At this moment more asphalt powder is dusted over the surface, which will adhere to that already melted. The excess is again carefully removed, and the plate is gently heated to incorporate the additional asphalt with that which was dusted on before. This second heating must be very carefully done lest the finer lines thicken by the spreading of the asphalt.

The back and margins of the plate must now be varnished with any quick-drying bitumen or shellac varnish. Whenever this is dry the plate is ready to be laid in the weakest of the three etching baths. Whilst it lies therein, the surface is continually worked over with a very soft brush, just allowed to touch the metal. This is to equalise the action of the acid.

After two minutes the plate is removed from the acid, is rinsed with water, and the effect is observed. If the action has proceeded quite evenly, the plate is returned to the acid. If, on the other hand, any parts of the lines appear to be breaking down under the action of the acid—a thing which may be due to error in any of the operations previous to dipping the plate in the acid—such parts must be retouched or put in by hand, using a thick solution of asphalt in turpentine, the plate being previously dried by

blotting off and gently heating. It is then returned to the acid bath for another period of two minutes, when it is again examined as before. If the lines be very fine, the plate will probably by this time have had all the etching that it can stand without further protection ; further etching endangering the lines by the under-cutting of the acid. Only experience can enable the operator to tell when he must stop the etching, but with work of average fineness, a third period of three minutes may be given. As soon as the finger-nail can catch on the margin line of the plate, the etching is deep enough.

The plate is now thoroughly rinsed, and is dried by blotting off and gently heating. The temperature is raised to between 110° and 120° Fahr., and very fine resin powder is dusted over it with a brush. The warm image holds the powder, and the excess can be removed by rubbing with a brush and cotton-wool, and finally by hard blowing. This blowing may be done with an ordinary pair of bellows, such as is in domestic use. Those who do zinc etching on a large scale by the process now described, commonly use a specially constructed bellows, which is in the form of a vertical cylinder, has a stand on the top for receiving the plates, and a tube which can be bent, so as to direct the blast on to any part of the image, whilst blowing is done by working a lever.

The temperature is raised a little, and a second application of powdered resin is made, and the plate is cleaned as before by dusting and blowing. The heat is now gradually raised till it is seen that the resin begins to flow, so as to widen the lines. At this moment the plate is removed from the heat, and asphalt powder is dusted over it. This is caught by the now tacky resin. The plate is cleared of the excess of asphalt powder, the temperature is raised to about 150° , the operation is repeated, and the temperature is raised till this last coating of asphalt powder thoroughly incorporates itself with the others. It will now be found that the *sides* of the lines have been covered with the flowing resin and asphalt with wonderful regularity. Indeed, there is much less difficulty than would

be expected in securing the regularity of flow, the only real difficulty, or rather the one thing that requires the greatest care, is the complete removal of the powder that falls on those parts of the plate between the lines. Any trace of resin or asphalt left there interferes greatly with the progress of the etching.

The plate now enters the first etching bath once more. Here it is etched as before for periods of two minutes at a time, a careful examination being made at the end of each period. The finest lines are always examined to discover if there is any sign of breaking down, a magnifying glass being used. If the operations of protecting the lines have been rightly done, the plate should stand at least two, very likely four periods, of two minutes each.

This finishes the etching in the first etching bath, which is supposed to give the depth required between very close lines, this depth being much less than that needed between lines which are somewhat far apart and still less than is required for large spaces which must print white.

The image is now cleaned with turpentine, the last trace of this being removed by rubbing the plate with sawdust. If the etching has gone on as it should, the image will appear clearly with the original polished surface of the plate, the remainder of the surface being dulled with the acid.

The image has now to be inked up again. The polished roller and a very thin ink are used for this. The ink is made out of equal parts of paraffin, tallow, bees'-wax, and ordinary printing ink. This ink should have about the consistency of butter. It greedily licks up resin, and, when warmed with this latter so as to be incorporated with it, forms a solid but somewhat brittle substance.

The plate is very carefully rolled up with this ink so that a very even coating is given. Scarcely any pressure is used, and only the tops of the lines should receive the ink. It is, however, impossible to prevent any large spaces between lines from taking the ink, nor is this of consequence, only next all lines there must be an inked space of at least $\frac{1}{8}$ inch wide.

The plate, inked up, is dusted with powdered resin till the ink will absorb no more of it. It is then dusted, and is warmed till the resin becomes tacky, but does not melt or spread. A second application of resin is now made, again to saturation, the plate is cleaned of excess, the temperature is raised to about 120° , and the plate is powdered with asphalt powder; the excess is again removed, the temperature is raised to about 150° , once more asphalt is applied, and the excess is removed. The temperature is now raised till the resin and asphalt flow and show a bright surface. The protective film is allowed to spread so that even the spaces between very fine lines are filled up, then, as has already been said, having been given all the depth that is required.

The back of the plate is varnished as before, and the protective film is scraped away from those portions of the wide spaces between lines where the ink having taken, the resin and asphalt have taken also. The film being brittle this removal is quite easy.

Etching now goes on in the second bath. It may be allowed to proceed during periods of three minutes each. At the end of each period the plate is examined as before, and any tendency to failure of the protective film is made good with the solution of asphalt in turpentine. As a rule, three or four etchings of three minutes each will give a sufficient depth, but the best way in which to judge of the action is as follows:—

A slight ridge will always show itself between where the etching in the first bath left off and that in the second began. This has, as will afterwards be explained, to be removed. The etching in the second bath should, however, be allowed to proceed so far that, by under-cutting or lateral action, the ridge is reduced to quite a trifling size. The progress may always be examined by scraping away a little of the protective film on the margin of the plate.

The plate, after sufficient etching has been given, is cleaned with turpentine and sawdust as before. The progress of the action may be judged of by noticing whether what we may call the “contour lines,” formed

by the ridge just mentioned, running along the *sides* of the lines, everywhere run parallel with the *upper edges* of the lines ; if all has been properly done, they will.

The third etching comes now to be done. The object of this is merely to eat away to a considerable depth those parts of the plate which are at some distance from lines.

The image is inked up with the soft ink as before, but this time a large quantity of ink is used and is freely applied, so that it not only covers the tops of the lines but works its way down the sides of them to some distance, filling in also the spaces between very close lines. If the roller refuse to do this in any part, the ink is forced in with a dabber.

The incorporating of resin and asphalt with the ink also goes on precisely as described before, the last heating allowing the covering to flow considerably. The large spaces between lines which may have taken ink are again scraped clean, the back is varnished, and etching goes on in the third bath.

Periods of five minutes each are allowed in this bath, and progress is judged of as before. The action is allowed to go on, that is, till the ridge between the result of the second and of the third etching is made quite small by the lateral action of the acid. Probably five or six periods of five minutes each will suffice. As a rule, the protective film will stand the necessary etching without breaking down. If, however, it shows signs of giving way—other than those purely local, which can be corrected by hand-touching with asphalt solution—the plate must be cleaned, again inked up, etc.

After the deep etching is over two more etchings are still necessary to remove the ridges left by the first three etchings.

The plate is cleaned ; inking and dusting on are performed in such a way that the protective film spreads sufficiently to cover the ridge nearest the lines, but not the second ridge (produced by the final etching), and the plate is etched for two or three periods of three minutes each in the second bath.

The plate is once more cleaned for the last etching. It is very carefully inked up with the thinnest ink and the lightest possible pressure, and is dusted only once with asphalt powder, which is heated so as to spread but slightly, not so far as to the first ridge. The etching is performed with great care in the first bath, periods of one minute each being allowed. When the last ridge has disappeared the etching is finished. The plate is once more cleaned, any small portions of either of the ridges which may have been left on account of the irregular spreading of the protecting film are removed with a graver; the plate is mounted on wood, so as to have the regular height of type, and is then ready to be put up with ordinary matter for the press.

The process which has been described is, as already stated, only one of several which are worked. It appears, however, to be the most easily worked of any. It is commonly known as the "Austrian method of etching." I have to mention my indebtedness to J. O. Mörch¹ for my knowledge of the details of the process, which I first acquired through his very clear description of it. The object of using first resin then asphalt in giving a protective film is that the resin, melting at a lower temperature than the asphalt, may be used as a means of attracting the latter at a moderate temperature, so that a thicker film is got than otherwise could be.

The method most commonly used in England differs considerably from the "Austrian" just described. It is sometimes called the "French method," to distinguish it from the other. I can here afford space only to describe the principles on which it depends.

A special etching or "resist" ink is generally used. It may be made up of bitumen, tallow, and bees'-wax thinned with lithographic varnish.

The plate is gummed in and inked up. It is then cleared of gum solution, is dried, and is powdered with

¹ *Handbuch der Chemigraphie und Photochemigraphie*. Nach eigenen Erfahrungen bearbeitet. Von J. O. Mörch: Düsseldorf Ed., Leisegang's Verlag.

ground resin till the lines have taken all that they will. The interspaces are then cleared of resin, the plate is heated very gently so as just to make the resin adhere, but not to incorporate it with the ink. The plate then is ready to have its back and margins varnished, and to go into the first etching bath. After a slight etching it is removed, is rinsed clean, and is heated till the resin is incorporated with the ink, and the mixture has flowed down so as to cover the sides of the lines. The plate is now once more gummed in, is inked up, has the gum cleared away, is dusted with resin powder, cleared of excess, gently warmed, allowed to cool, and is treated with a second etching bath which may be a little stronger than the first. The whole process is thus performed over and over again, gradually increasing the strength of the bath until the necessary depth is gained. The number of etchings necessary will vary much with the nature of the work. The finer the work the less it is possible to etch away at a single operation, and the greater must therefore be the number of etchings be. Over a dozen etchings are often needed.

After the necessary depth has been got in the way described it is necessary to remove the "contour lines" as in the case of etching by the Austrian method.

CHAPTER XLVI

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

The Asphalt Process for the Production of Line Relief Blocks

General Principles.—The method of producing surface blocks by the transfer method described in the last chapter has certain drawbacks. Thus the damping of the transfer paper produces a slight amount of distortion. This is so small that for the great majority of subjects it is not of consequence, but where great precision is necessary this distortion may be a serious drawback. Moreover, unless the process be carried out with the extremest skill, there is a liability to loss of delicacy in the finer lines.

When distortion is inadmissible, or indeed, whenever the finest work is wished for, it is best to print directly on a film of asphalt on the surface of the zinc plate.

Asphalt, bitumen, or mineral pitch, was used in camera photography in the very earliest experiments made by Niepce. In 1814 he made camera pictures by its aid. The substance is sensitive to light, inasmuch as, when dissolved in benzole, chloroform, or other solvent spread in a thin film, and allowed to dry, light has the effect of rendering it no longer soluble in these fluids.

The length of exposure necessary to render an asphalt film insoluble is very great, but it has been materially lessened by the discovery that a certain portion of the bitumen is soluble in ether, that this portion is quite insensitive to light, and that, if it be removed, what remains

is much more sensitive than is the bitumen before it is thus treated.

If a zinc plate be covered with a thin film of varnish, made by dissolving in benzole, the residue left after dissolving in ether as much of the bitumen as is soluble, if this plate be exposed under a line negative, and be then developed by dissolving the bitumen from those parts which have not been acted on by light, the result is an image in bitumen which may be etched in the manner described in the last chapter.

Preparation of the Bitumen Varnish

The usual method of preparing the bitumen for photography is to powder the asphalt, and to soak it in ether till all that could thus be dissolved away was taken up by the ether.

However carefully this process is carried out, a certain amount of ether-soluble bitumen is still left behind, with the result that the residue gives a film less sensitive than the asphalt is capable of giving.

In 1885 Husnik proposed a modification of the process by which a varnish of great sensitiveness is obtained. The process is described in the *Photographic News* of July 3, 1885.

The bitumen is reduced to a coarse powder, and is dissolved in rectified turpentine. By allowing sufficient time the turpentine will dissolve a large quantity of the asphalt. In three days, if it be frequently stirred, one-third of its own weight.

When the turpentine is thoroughly saturated ether is poured into the solution. The ether at first has the effect merely of thinning it; but when about 2 parts of ether have been poured into 1 part of the bitumen solution, a doughy precipitate begins to fall.

To discover if all the bitumen not soluble in ether has been precipitated, a little ether is placed in a test tube, and a few drops of the mixture of ether, turpentine, and bitumen is poured into this liquid in the test tube. If a preci-

pitate results, it proves that all the available bitumen has not been thrown down; and the addition of ether is continued till, when the test is applied, the supernatant liquid simply mixes with the ether in the test tube.

The solution is allowed to stand for twenty-four hours, when the supernatant fluid is poured away. The precipitate which remains behind amounts to about half the original bitumen. Fresh ether is poured over the precipitate, which is occasionally stirred up during two or three days. This causes it to become considerably firmer on account of the removal of the last trace of the turpentine, and also of the bitumen soluble in ether.

The last portion of ether is retained to be used again, when it is desired to prepare sensitive bitumen again. The precipitate is removed with a bent strip of zinc from the vessel in which it was thrown down; it is placed in a porcelain dish, and is allowed to remain in a warm place for several days, with occasional stirring to secure the complete removal of the ether, when there remains a hard, extremely brittle, glittering black mass, which is readily reduced to powder by hand.

The prepared bitumen is powdered and is dissolved in benzole, the solution being made of such strength that it will flow like collodion, and to each 100 parts of the solution is added $1\frac{1}{2}$ part of Venice turpentine. The benzole must be quite free from ether. If it is not, the varnish will flow in drops on the plate in place of flowing evenly. This defect can, however, be remedied by adding some chloroform to the varnish.

Coating the Plates

The plates themselves are zinc plates like those mentioned in the last chapter, but they should be very thoroughly polished. After being smoothed with emery cloth, as described for zinc plates in the chapter on Collotype, they should be further polished; first, with pumice powder, then with rotten stone, and finally, with rouge.

The object in coating a plate with bitumen varnish is to get a very thin but quite even film. The thinness is desirable, because the films at the lines must be rendered insoluble not only on the surface but right through to the plate; and if the film be thick, the exposure required for this will be excessive. It is possible to coat by hand, as a glass plate is coated with collodion; but far the best results will be got by using a "turn-table." This is simply a disc of wood or metal placed horizontally, with an arrangement for clamping a plate down to it, and with appliances whereby it may be made to revolve rapidly on a vertical axis.

Turn-tables or "whirlers" may be purchased, but many ways in which such an appliance may be made will suggest themselves to an operator of any ingenuity, especially if it be borne in mind that a velocity of two or three revolutions per second—one that can easily be given directly by hand to a small crank—is quite sufficient.

The zinc plate is placed on the turn-table, a pool of the sensitive solution is poured on the centre of it, the whirling is begun and is kept up for a minute or so. The result is a film of incredible thinness and of perfect evenness which will probably be dry by the time that the whirling is stopped, as the motion increases the rapidity of evaporation of the benzine. The film should show as little more than slight golden tint.

Exposure and Development of the Plates

As for all photo-mechanical line processes, it is desirable that the negative show the lines quite clear on a background as opaque as possible. The necessity for opacity is greater in the case of the bitumen process than in that of others. Also, as the contact in the frame is between two ridged surfaces, it is necessary that plate glass be used for the negatives.

The plates should be laid on one side in the dark for some twelve hours so that the films may harden; and just

before exposure they are dusted with French chalk to remove any remains of tackiness.

The exposure, if the lines of the negative be quite clear, and if the varnish be prepared as described, will be about fifteen minutes to the brightest sunshine or a corresponding time to diffused light.

To develop the plate a mixture of benzole and turpentine is used. Benzole alone cannot be used as it is so energetic a solvent of bitumen that it would dissolve away even that which has been acted upon by light. Turpentine, on the other hand, acts too slowly.¹ It is well, however, to begin with turpentine, and gradually to add benzole as appears necessary. The plate is simply flooded with the mixture, when the parts of the film between the lines begin to dissolve. At the end it may be necessary to assist the action of the solvent by gentle rubbing with a tuft of cotton-wool or a very soft brush; but the greatest care must be taken or the lines may be damaged. If the whole of the ether-soluble bitumen has been got rid of, the solvents should complete development without mechanical aid.

Etching the Plate

The etching is performed just as described in the last chapter, but that the plate may be placed in an extremely weak first etching bath to receive a very slight etching without the application of powdered resin or bitumen, the thin bitumen coating already on the lines being more resistant of acid than the mere ink coating given by the transfer process. The image got by the bitumen method is exquisitely clear and sharp if all has been properly done.

¹ Bolas, *Cantor Lectures*, "The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment," 1878.

CHAPTER XLVII

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Other Methods of Producing Line Relief Blocks

BESIDES the methods already mentioned or described for producing line blocks in relief, there are innumerable others. The majority of these it will be impossible even to name here, and only one can be described with anything approaching detail. This is the albumen process. The leading principles only of a few others will be given.

The albumen process is one that is justly popular. It is capable of producing work that, if not quite so fine as the best that can be done by the bitumen process, is nevertheless very fine, and, in fact, sufficiently good for all but the most delicate work. The process, moreover, presents no difficulties that cannot be got over with a little perseverance, and it is very expeditious.

Zinc plates are used, as in the processes just described. These may be polished, as is described for the bitumen process given in the last chapter, but it is better, on the whole, to grain the plate, if for no other reason than that it makes the work show up much better. To secure the grain the plate is first polished with the emery stick and the finest emery, and is then treated with a mixture of

Water	.	.	.	.	.	.	40 ounces
Saturated solution of common alum	.	.	.	.	.	.	1 ounce
Nitric acid	.	.	.	.	.	.	1 dram

A large quantity of this is flowed over the polished and

cleaned face of the zinc in a dish that is kept rocking till a frosted appearance is produced. The plate is then rinsed and dried, when it is ready to receive the sensitive coating. It is just possible for a very skilful manipulator to coat zinc plates with the albumen solution by hand, but it is exceedingly difficult to get an even coating, and the use of the whirler is recommended.

The sensitive solution is merely a mixture of albumen, water, and bichromate of potassium. The proportions of the various ingredients may be varied considerably, and still give films that work well. With the amount of bichromate of potassium commonly recommended the sensitiveness of the films is very great, and the exposure in consequence comparatively short, being in a good light only a few minutes. This is, of course, in itself an advantage, but the writer considers that it is, on the whole, better to keep the quantity of bichromate low, sacrificing a little in sensitiveness, but, he thinks, making the general working of the process more sure than when the quantity of bichromate is large.

The following formula has been found to work well :—

Albumen	.	.	.	.	.	1 ounce
Water	.	.	.	.	.	6 ounces
Bichromate of potassium	.	.	.	.	.	20 grains

The albumen is to be thoroughly frothed by whipping, the bichromate is dissolved in an ounce or so of the water, the remainder of the water is added to the albumen, and finally, the bichromate solution is added to the mixture of albumen and water.¹

This *solution* is probably almost insensitive to light, but it is well to be on the safe side and not to expose it more than necessary. It must be borne in mind that the film, at any rate when dry, is exceedingly sensitive to light, and that it must therefore not be exposed to any but the faintest white light.

¹ Wilkinson recommends the very convenient method of mixing the albumen and the water together, of placing them in a bottle along with a quantity of broken glass, and shaking the whole for one minute.

The coating of the plate is done by flowing it freely with the mixture and whirling. The film got is very thin. If it be free from air bubbles it may be dried at once. If it show any of these, it is best not to try to doctor it, but to rinse off the solution at once, and to flow and whirl again. Whenever a film free from mechanical imperfections has been got, it is dried by very gently warming the plate over either a Bunsen burner or a charcoal fire.

Whenever the film is dry the plate is ready to be exposed under the negative. The exposure is made in the usual way, a printing-frame with screws to give a considerable pressure being advisable for all but very small work, so as to ensure contact. The negative, it will be understood, is of the kind generally needed for photo-mechanical line work. Lines clear, the rest dense, the denser the better. Excessive density is not, however, so essential in this process as with bitumen films.

The exposure will not be long, even if the amount of bichromate used be small, as recommended. It is best estimated by an actinometer, although the image is visible. The effects of under and over exposure will be described hereafter.

The exposure having been finished, the next thing is to convert the image, already visible, as has been said, into one that is etchable. The first operation is to cover the whole film with a very thin coating of ink. On the evenness of this coating depends, in great measure, the success of the process. It should be even, and so thin that the image is just barely visible through it.

A small quantity of transfer ink is thinned with turpentine till it can be spread with a composition roller quite evenly and thinly over the inking slab. From this the film is then covered by continuous rolling in different directions, with a thin even film as described.

The image is now to be developed by laying the plate in water for two or three minutes, after which the surface is gently rubbed with a tuft of cotton wool till all the ink-covered film but that representing the lines will, if the exposure have been correct, wash away, leaving the image

clear and distinct. If the finer lines wash away with the rest it is a sign of under-exposure. If there is difficulty or impossibility in clearing the spaces between the lines, it is a sign of over-exposure.

The processes that follow the clearing of the image have all been already described. The plate is gummed up, is fanned dry; it is damped once again, and the image is inked up till it will take no more ink. The last of the gum is then washed away, and the plate is etched exactly as described for a transfer.

The Gelatine Process

Gelatine is sometimes used instead of albumen in the process just described. It has the advantage that there is less difficulty in getting an even film. The coating can quite easily be done by hand. On the other hand, the films are less sensitive, and the results are likely to be less delicate.

The following formula may be used:—

Gelatine	1 ounce
Bichromate of potassium (dissolved in about an ounce of water, and converted into double chromate of potassium and ammonium by the addition of ammonia as already described)	30 grains
Water	20 ounces

The film should be made as thin as possible. It is to be dried without the aid of heat. The water used in development must be warm, but in all other respects the process is the same as that just described.

Process of Casting from Gelatine Reliefs

We come now to a brief consideration of a process entirely different from those which we have been considering. It had its origin, I believe, with Poitevin and Pretch. A few words will make the general principle quite clear.

If a plate be coated with a film of bichromated gelatine, if this film be exposed under a line negative, and the plate be simply soaked in cold water, but be not developed in warm water, the part of the film which has been protected from light will swell up to a considerable extent, leaving the lines in deep relief. A casting from this swelled gelatine will now give the lines in high relief, and will form a printing block, if it be made in a suitable material, to stand the wear and tear of the printing-press or machine. As a matter of fact a casting of such a nature cannot be made *direct* from the gelatine relief, but has to be made in a roundabout way. The following is the method recommended by Bolas :¹—

Sheet gelatine is prepared by thickly coating a waxed plate with a gelatine solution, and drying it at a moderate temperature. The solution may be made of 1 part soft gelatine, 5 parts water. A sort of dish must be made of glass plate by piling up a rim of wax round the edge, or by some such method, and the solution must be poured in to a depth of about $\frac{1}{5}$ inch. As the coating and drying of such a plate is a very troublesome affair, it is strongly recommended that the sheet gelatine be purchased ready prepared from Mr. Cornelissen of Great Queen Street, London.

“To make the gelatine solution sensitive to light, it is soaked in a $3\frac{1}{2}$ per cent solution of potassium bichromate till it becomes flaccid, it is then laid on a piece of clean (waxed) glass, and the excess of solution is removed by the application of the squeegee. The plate bearing the wet gelatine is then placed in a warm, photographically dark, place to dry, and when dry it can be easily separated from the glass by raising one corner with a penknife. We obtain in this way a flat sheet of sensitive gelatine,

¹ *Cantor Lectures*, “The Application of Photography to the Production of Printing Surfaces and Pictures in Pigment.” Six Lectures delivered before the Society of Arts, by Thomas Bolas, F.C.S., London, 1878. The process is much more fully described by the same author in the copies of the *British Journal of Photography* for January 3 and 17, 1879.

having a smooth surface and all ready for exposure under a negative, and the exposure may last from ten to twenty minutes in sunshine, or a correspondingly longer time in the shade."

The sheet is now allowed to soak in cold water for several hours. At the end of this time it will be found that the lines are in deep relief. The film is now squeegeed, exposed side upwards, on a plate of clean glass. It is made surface dry by dabbing with a clean cloth, and a little oil is applied and evenly distributed over the surface. Plaster of Paris is now poured on the film to a thickness of about an inch, care being taken to remove any air bubbles by the application of a camel's-hair brush through the plaster.

When the plaster cast has set quite solid it, together with the gelatine film, is removed from the glass by a sliding motion. The gelatine film is now removed from the plaster cast by taking up one corner and slowly drawing it away.

We have now a perfect relief block, but one in a substance far too brittle to be printed from. From this block a cast is made in stearine. The plaster cast is heated to a temperature of about 120° Fahr. by dipping it in hot water, and a casting is made on it of stearine, about an inch thick. When this casting has thoroughly hardened, it is separated from the plaster of Paris, and the surface is powdered over with bronze powder to cause it to become a conductor of electricity. Bolas recommends particularly the powder made by Allan of Mansfield Place, Kentish Town, London, which is specially prepared for electrotyping purposes. The cast powdered with bronze powder is placed in the ordinary electrotyping bath, and when a sufficient quantity of copper has been deposited, the image thus got is backed up with type metal, and is mounted on a wooden block so as to be type high.

As delicate results are not to be expected from the process just described as from an etching process. The boundaries of the lines, in place of being quite sharp, are somewhat rounded. This defect might be got over by exposing the film under a *positive*, and washing out the

lines with warm water down to the glass, or to a thin substratum on the glass, and taking a cast from the resulting deep relief plate ; but there are many practical difficulties in the way which have not, so far as I am aware, been entirely overcome.

Husnick's "Leimtypie"

In this process, which is quite new, and of which I can only say a few words, the difficulty above referred to is entirely overcome. The process differs from all others inasmuch as the printing is done from the gelatine itself. When it is considered that a gelatine relief, such as we have in the case of the Woodbury-type process, may be forced into solid lead without being in any way damaged, it does not appear at all surprising that a phototype, in which the lines are actually of gelatine, should stand the wear and tear of the printing-press, or even that, as has been stated, an edition of 32,000 has been printed from a single block.

I am unable to give any details of the process as worked by Husnick, beyond that in which consists the whole of the novelty of the process. Development is done with a cold saturated solution of bichromate of potassium, the action being assisted by rubbing with a brush or the like. I can, however, give, in very brief outline, the way in which my friend Ogawa has successfully worked the process.

Thick plates of glass are coated with a considerable quantity of bichromated gelatine. The formula, and also the quantity recommended for Woodbury-type, will be found to work well. The same manner of drying at a moderate temperature is also suitable, but no collodion substratum is used. The plate is exposed under a line negative, a moderate exposure to light being given to the back, either before or after the main exposure, to secure adhesion of the film. After this the plate is allowed to soak in cold water, and is then developed by rubbing the surface with a brush in a cold saturated solution of bichromate of potassium, which has not the effect of

partially softening the lines as hot water has. When a certain depth has been got, and there would be danger that the finer lines would give way were the operation carried farther, the film is dried again—without washing. It is then covered with printer's ink dissolved in turpentine, leaving, however, the lines, and a very narrow space alongside of them, clear. An exposure to sunlight which, of course, affects the lines only, still further hardening them, is now given, the ink is removed, and development proceeds again. This process may be repeated several times if necessary and corresponds pretty closely to the repeated etchings of a zinc plate. When sufficient depth has been got the plate has only to be dried, when it is ready to be mounted type high and to be printed from.

CHAPTER XLVIII

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Processes for Producing Entaglio or Engraved Line Plates

IN entaglio line processes the lines are cut into the surface of the plate in place of being raised, and the process of printing consists in filling up the lines with ink, or rather covering the whole surface of the plate with ink, wiping that which is not buried in the lines away with a cloth, then bringing down with great pressure on the surface of the plate a sheet of paper backed with some more or less elastic backing. The ink is pulled out of the lines by the paper, giving, of course, a complete image of the engraving or etching.

The advantage of any entaglio process when it is a case of hand-work is very evident. The artist draws or cuts on the surface of the plate the actual lines that are to appear, in place of going through the roundabout process of cutting away everything that is not to appear black, leaving the lines in relief. The consequent freedom of touch is very evident, and especially in the case of etchings. In hand-etching the work is done by a needle either on a thin film of wax on the surface of a copper-plate—the plate being afterwards etched—or directly on the surface of the metal, the work being more analogous to the work of the pencil and the pen than in any other kind of hand-work, producing directly blocks or plates capable of being printed from, except perhaps drawing or transfer paper for the

lithographer, which again gives much coarser results than copper-plate etching.

In photographic reproduction processes the entaglio plate has no such advantage over the type block. In either case the artist's work is the same. He draws on white paper with black ink. From this drawing a type block or an entaglio plate may be made at the will of the operator; but there will be but little difference between prints from the two. Both will reproduce all the character of the artist's drawing.

It is true that if sufficient care be given to the printing, and if a very fine quality of paper be used, there will be somewhat more of delicacy in the case of the print from an entaglio plate than in that from a type block. Particularly will this be the case in copies of copper-plate etchings.

In an etching of the kind just mentioned not only does the width of the lines vary, but to a certain small extent the depth or colour of them varies also. It is not an uncommon method for an etcher to put in the main part of his work on wax, to etch the plate, take a proof, and then put in what work appears to be required to modify the effect by the aid of the "dry point,"—that is to say, simply scratching the surface of the copper; these scratchings being of the smallest conceivable depth and holding so little ink that they do not actually print black, but of a gray or brown tint according to the nature of the ink that is used.

There is no process really analogous to this in the case of printing from a type or raised block, although the printer may do something by packing up the back of the paper to different heights, so that the pressure on the surface of the block is different at different places.

In reproducing an etching by photography, it is easy to reproduce the different depths of etching in the original as will be explained.

It may be stated as a general rule that any process which is applicable to the production of a line type block is also capable of producing an entaglio plate if a transparent positive be used in place of a negative. The most

suitable metal for entaglio plates is copper. This is scarcely applicable where type blocks are needed, as the great depth to which these have to be etched would make the process very tedious with the harder metal ; the amount of etching or biting needed for entaglio plates is, however, so exceedingly small, the deepest lines only having to be bitten to about $\frac{1}{200}$ of an inch, that this difficulty does not stand in the way.

The process which will be found the most suitable is the asphalt process. As has been explained, it is only in cases where the work is of the most delicate nature that the entaglio process offers any advantage over the type block process, and it is of course not desirable to lose any of the delicacy in the intermediate steps, as may be the case if gelatine or albumen be used, especially the former. The objection to using an engraved plate where a type block will give as good a result is the comparative slowness of printing from the former, and the fact that it cannot be printed along with type.

If the transfer method be used for the reproduction of a line subject, it is almost necessary to use zinc, which is by no means a very suitable metal for engraved plates. Moreover, where the area of the lines occupies but a small portion of the surface of the plate, certain precautions must be taken. The reason for these precautions is as follows : If a transfer be made from the positive, which represents such a subject, the greater part of the surface of the transfer will ink up or will retain the ink after development, and on attempting to lay this down on a plate, it will slide over the surface and a smear only will be the result. To prevent this the positive is given a good wide edging of opaque colour, and wherever there is a considerable space between the lines, this is filled up with colour, leaving, however, a space of at least $\frac{1}{16}$ inch between the patch thus put in and the line. This results in a transfer having a considerable amount of area without ink, and the image can readily be transferred to a plate. After it has been transferred, and has been strengthened with resin and asphalt powder, the spaces are filled in by

hand with asphalt varnish, when etching goes on as will be described. This process is only suitable where a few copies are needed.

The etching needed for entaglio plates is so small that it is never necessary to build up the film of asphalt by powdering with resin, etc., and heating. I here assume that the asphalt process—which is the only one really suitable for producing such plates—is used. The transparency, or diapositive, that has been spoken of as necessary should show the lines as opaque as possible, and should show the interspaces quite transparent.

The copper plate is to be prepared exactly as described for a zinc plate to be etched for the production of a high relief block—that is to say, so far as the preparation of a film of bitumen on the surface of the metal is concerned. The plate is exposed under the positive, is developed with a mixture of benzole and turpentine, and is placed at once in the etching fluid.

Dilute nitric acid may be used for etching a plate such as that described, but the following is very generally preferred :—

Potassium chlorate	.	.	.	.	1 ounce
Hydrochloric acid	.	.	.	.	10 ounces
Water	.	.	.	.	50 „

A solution of perchloride of iron may be used. Such a solution has the peculiarity that, if it be quite saturated, it has little or no etching effect on copper, whereas, if the saturated solution be diluted even slightly, it bites quite readily. It is thus possible to regulate the process to a nicety. For ordinary work a suitable strength of solution will result by mixing a quantity of a saturated solution of the salt with an equal quantity of water.

Whatever etching fluid or “mordant” is used, the amount of etching needed will be found to be very slight. It can only be determined by experience. Whether it is desirable to stop the process in some of the lines by removing the plate from the bath, rinsing it, drying it, and covering the lines with bitumen varnish, is also a thing

that can be determined only by experience. It is by so doing that the very fine lines of copper-plate etchings already mentioned are reproduced.

If the albumen process be made use of, the etching should be done with an alcoholic solution of perchloride of iron.

In whatever way the plate is etched, the protecting film is cleaned away from it when it comes from the etching fluid, and it is then ready for the copper-plate press.

The process of printing is briefly as follows :—

The plate is inked by rolling over it a roller which carries a thick film of ink on it, or the surface is dabbed all over. In any case, the whole surface of the plate must be covered with ink. The greater part of the excess is removed with a cloth, and then finally with the flat of the hand, which has previously been covered with whiting to prevent the ink from adhering. This last process looks simple when performed by a skilled printer, but really requires much practice. A damp sheet of paper is laid on the plate, and the two together go through the press, which generally consists of a flat heavy metal plate on which the plate is placed, and a roller which applies pressure to the back of the paper through a pad of blanketing or some other elastic substance. Sometimes a press with a platen coming down with great pressure is used.

The printing of copper-plate impressions is a special trade, and is one, moreover, involving great skill. The most skilful copper-plate etchers generally send out their plates to be printed from. It is therefore certainly not recommended that the photographer attempt his own printing. If, however, he have any kind of press by the aid of which he can pull a proof or two—a lithographic or collotype press will serve very well—it will be useful for him to be able to do so, so as to judge, without sending his plate to the printer, whether or not re-etching is needed. Re-etching is needed if the biting has not been carried far enough—a thing that is indicated by general lightness of the proof.

The process of re-etching is as follows :—

A “resist” ink is made up by mixing one part of

yellow wax with five or six of common lithographic ink, thinning with a little middle lithographic varnish, if the resist ink is otherwise too thick to be worked. A very thin and even coating of this ink is spread over the inking slab, and, using the red lead roller described in Chapter XLV., p. 353, for applying the ink for the final stages of etching high relief zinc blocks, a thin film of this ink is spread over the surface of the copper plate. In some cases it is an *advantage* if the ink fill up the very finest lines, but, if it be wanted to darken all the lines and some be filled up, or if any lines be filled up that need further etching, they must be cleaned out with a needle point.

The inking having been satisfactorily done, the plate is thoroughly dusted with resin, is gently heated till the resin just melts, is varnished on the back, and may then be re-etched to any extent deemed necessary.

CHAPTER XLIX

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Half-Tone Processes, preliminary

Preliminary Statement.—None of the processes that we have been considering since that of Stanotype is capable of giving a true half-tone. A little consideration will, however, show that, if half-tone be represented by, or translated into, a stipple, lines, or into a stipple which is made up of dots or points, it might be reproduced either by photo-lithography, by the aid of a phototype block, or of an entaglio engraving, there being in such a case no true gradation, but something in black and white which represents it, if we do not look too closely.

There are many ways in which a negative or a photographic print may, with greater or less success, be broken up into a stipple, and it is a common thing to point out that if once a negative be so broken up, it may be reproduced by any of the three methods just mentioned, and no doubt this is in a certain sense true. If a pretty wide stipple be got this may be transferred to a stone, and proofs may be pulled from a stone, or it may be transferred to zinc, and the zinc may be etched to produce a type block, or an entaglio plate may be made from it.

But though all this is true, still, if a photograph be rendered in an exceedingly fine stipple—one so fine, say, that it is not visible to the naked eye—a very perfect entaglio plate may be made from it; but if an attempt be made to produce a surface block from it, the fineness of

the grain will make it impossible to etch to such a depth as will give a printable block ; and if an attempt be made to transfer it to a stone and to pull prints, little more than a smear will be the result.

It may be said generally, that whereas a fairly open stipple is necessary for producing lithographic work, a much finer stipple may be used for type blocks, and a still finer grain for entaglio plates. The coarse grain applicable to stone *may* be used for type blocks, but as a finer grain is admissible, it is advisable to use this latter. The still comparatively coarse grain applicable to a type block *may* be used for an entaglio plate ; but no better result will be got from the plate than from the block, whilst, as a finer grain may be used with the plate, it is certainly advisable to do so.

This being the case, I have decided to treat the rendering of half-tones under three different heads ; but here I must state that this part of my work must of necessity be by far the least complete of the whole. The general principles on which half-tone may be rendered have, it is true, been published ; but, as a rule, general principles only have been announced, and it may really be said that on these general principles almost less depends than on innumerable details of practice which have either been kept secret purposely, or which could not be published, inasmuch as they are really matters of practice—of manipulative skill—rather than of explicable method. The conjuror may explain the principle of some of his tricks. The sleight of hand, whereby he is able to deceive with them, comes only by a combination of skill and natural aptitude, and after long practice.

Take, for example, type blocks. So far as I know these are produced, with any degree of real success, by three methods only. Dallas has for a long time produced them of excellent quality. In fact, he may be considered in this country as the pioneer of various photo-mechanical printing processes ; but his methods have never been divulged, although it is generally supposed that they are based on Pretch's "swelled gelatine process." The Meisenbach and

the Ives processes are much worked, both by the firms bearing the name and others ; but it is almost certain that many unpublished points of detail contribute to the wonderfully fine results that are got by some of those who work it. Still, of both processes enough has been published to make it possible for a clever operator to learn to work them, but it need not be expected that anything like perfection will be reached without long and tedious practice, and until many failures have been made.

The process of Ives is to my mind the most scientific of any grained half-tone process, yet others practically the same have failed in less skilled hands than those of Ives.

I say that the three processes above mentioned are the only ones which are, to my knowledge, at all extensively used, yet other processes have been published, of which it might, I think, certainly be said that they contain the germs of as great success as do any of these three ; but these processes have fallen quite flat for the want of that determined work and constant attention to a thousand small details that are necessary for success with a photo-mechanical process, and especially perhaps a type-block process.

I think it might, in fact, be said that, in the matter of photo-mechanical processes,—perhaps particularly of type blocks,—the nature of the process is a smaller factor in determining success or failure than the worker of it. An intelligent worker, giving the time and attention necessary to work up a process, will get good results with any out of a dozen or two ; but such instruction as can be given in writing will be of but little aid. One without intelligence giving great time and care to working up the matter will fail with whatever process he attempts, and to him, too, written instructions will be of little avail.

It is needless to say that a thorough knowledge of the manipulations of line processes is of the greatest advantage to one who intends to attempt half-tone processes.

CHAPTER L

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Methods of Obtaining Half-Tone in Photo-Lithography

Asser's Process.—This process was one of the first that gave results of any degree of success in photo-lithography. The following is a brief description of the manipulation :—

Unsize¹ paper of an even texture is taken. A starch solution, of somewhat less thickness than is commonly used for mounting or for such like purposes, is made up, and one side of the paper is thinly coated with this by the aid of a sponge.

The paper is now dried, and is floated film side upwards on a saturated solution of bichromate of potash till the colour indicates that the salt has penetrated the starch film through the paper. The sheet is then dried in the dark.

The paper, after it has been treated as just described, is sensitive to light. It should not be kept for longer than a day or two before it is exposed. The negative for this process need not be reversed. It should be of good quality and brilliant. The exposure may be judged of by examination, being stopped when the finer details of the lights show themselves. The image is of a brownish colour.

¹ Bolas recommends the use of blotting-paper, but the writer has found it very difficult to work such except in very small sizes on account of its extreme softness when wet. Rives's paper may be soaked in very hot water to remove any size it may contain, and will be found to work well.

The sensitive tissue is now laid film side upwards on the surface of a bath of cold water till the bichromate is all washed out of the film through the paper. When the yellow colour has disappeared, the paper is surface dried between blotting-paper, and is then allowed to become completely dry at an ordinary temperature.

The paper has now to be heated to a very considerable extent. It is difficult to give precise directions as to how much it should be heated; but it may be said that the heat should just be short of what will make the paper brittle or discolour it. The heating may be done in front of a clear fire if the operation be performed with care. Asser himself, I believe, advised that the sheet be laid on a slab of marble that had been heated. Bolas advises the application of a hot iron to the back of the sheet, and the writer has found this to be a quite satisfactory plan. The effect of the heating is to cause the sensitive starch which has been acted upon by light to absorb lithographic ink with great avidity.

The image is now damped by laying it for some time between sheets of wet paper under some pressure, when it is ready to be inked up. It is laid on a piece of plate glass—the image upwards, of course—the surface is blotted off with a piece of perfectly dry blotting-paper, and a roller charged with ink of medium thickness is passed over the surface. A granular image is thus produced, which may be transferred to a stone in the following manner:—

Weak nitric acid is made up as directed for etching a lithographic stone (Chapter XXXVIII.) A polished lithographic stone is warmed, as also described in that chapter. The inked Asser transfer is now damped on the back with the nitric acid mixture either by the aid of a sponge or by floating it, it is laid on the warm stone, and the rest of the process is performed exactly as described for an ordinary transfer. The stone is then printed from in the usual manner.

It will be understood that a much higher degree of skill in printing, and a greater accuracy in the press, are needed

when a half-tone subject is being treated than in the case of a line subject of the ordinary character.

Transfer from Collotype Plate

An examination of photo-lithographic prints in half-tone which, in commercial practice, have been most satisfactory, can leave very little doubt that in many cases the grain which they show is one obtained by the reticulation of gelatine. Is, in fact, the same grain as is to be seen in collotype, but that it is more open than it is desirable in the case of the latter process, in which the attempt is always made to keep the grain as fine as possible, and in which, in practice, it is kept so fine that it would give no satisfactory results if transferred to a lithographic stone.

Pretch, at a very early date, took advantage of the reticulation which is now taken advantage of in the collotype process, for the purpose of producing, by casting from the reticulated surface, type blocks representing half-tone, and it was a very small step to ink up the reticulated film to make a transfer from it to a stone, and to print from the stone. It was, nevertheless, only quite recently that the process became one of at all general applicability. In this country the process has been most successfully worked by Messrs. Sprague and Co.

Unfortunately the details of the process as worked commercially have not been divulged, but it may be stated that, if an image, such as is produced in collotype work, but with a very open reticulation, be got, there need be no difficulty in making a transfer from this to a stone, and in printing from the stone. Fortunately, too, there is no need to take the many precautions which are necessary in the case of collotype surfaces from which a great number of prints have to be taken, to secure firm adhesion of the film to the support. These precautions, or at least some of them, tend to a fine grain.

The following formula, which is due to Bolas, has been found to give a very open grain :—

Gelatine	6 parts
Water	60 „
Bichromate of ammonium	1 part
Chloride of calcium	2 parts

A plate is prepared as in Husnick's process of collotype, described in Chapter XL., but a considerably thicker coating is given than would be considered desirable for collotype. The film is dried at a high temperature, say 140° or 150°. The exposure of the back of the plate to light is omitted.

The plate is developed in the usual way and is inked up. An impression is taken on transfer paper, and is transferred to a stone, as has already been described. Probably a better transfer will be obtained if some half-dozen copies be first pulled on plain paper.

It will be seen that if the process be performed as described, a reversed negative will be required as in the case of collotype printing; whereas, if the collotype surface were applied directly, an ordinary negative might be used.

Various methods have been suggested to enable the image to be directly transferred to the stone, a flexible support being the only essential. The use of gelatine skins, as in the heliotype process, and the use of a sensitive film supported on paper have been recommended.

Whilst the first edition of this little book was in the press, J. Husband, Sergeant-Major, R.E., published in the *Journal of the Photographic Society of Great Britain* a process for "Practical Lithography in Half-Tone." This is, so far as I know, the first time that a process has been published with all working details, and the publication is of great value. I quote it in its entirety here:—

"Description of Husband's Papyrotint Process"

"This process has been named papyrotint, being a modification of Captain Abney's improved method of photo-lithography, named papyrotype. It is specially

adapted for the reproduction of subjects in half-tone, such as architectural drawings in monochrome, or subjects from nature, and it is inexpensive. Its advantages over other methods of half-tone photo-lithography are, that a transfer can be taken in greasy ink, for transfer to stone or zinc, *direct* from any negative, however large, without the aid of a medium, the grain or reticulation being obtained simply by a chemical change. The transfer paper being in direct contact with the negative, the resulting prints are sharper than by those processes where interposed media are used; whilst the same negative will answer either for a silver print, platinotype, or a transfer for zinc or stone. The advantage of being able to use a non-reversed negative is very great, now that gelatine plates have so largely superseded those made with collodion.

"The method of manipulation is as follows:—Any good surfaced paper is floated on a bath composed of—

" Gelatine (Nelson's flake)		8	ounces
Glycerine		1½	"
Chloride of sodium (common salt)		2	"
Water		50	"

Great care should be taken that the solution is not overheated, and that the paper is coated without bubbles. It is then dried in a temperature of 60° Fahr. The paper will take about ten hours to dry, and in this state will keep for years. When required for use, it should be sensitised by floating, or immersing, in a bath of—

" Bichromate of potash		1	ounce
Chloride of sodium		½	"
Ferricyanide of potassium		100	grains
Water		30	ounces

This need not be done in the dark room, as the solution is not sensitive to light.

"The paper, after sensitising, is dried in a temperature of 70°, and in a dark room. When dry, it is exposed under any half-tone negative, in the ordinary printing-frame. It is preferable to print in sunlight, and, for

negatives of medium density, an exposure of three minutes is required; but the exposure will vary according to the density of the negative. The correct time of exposure can best be judged by looking at the print in the frame. When the image appears on the transfer paper a dark fawn colour on a yellow ground, the transfer is sufficiently printed. It is put into a bath of cold water for about ten minutes, until the soluble gelatine has taken up its full quantity of water; then taken out, placed on a flat piece of stone, glass, or zinc-plate, and the surface dried with blotting-paper.

“The action of the light has been to render the parts to which it has penetrated through the negative partly insoluble, and, at the same time, granulated. A hard transfer ink is now used, composed of—

“ White virgin wax	.	.	.	$\frac{1}{2}$ ounce
Stearine	.	.	.	$\frac{1}{2}$ ”
Common resin	.	.	.	$\frac{1}{2}$ ”

These are melted together in a crucible over a small gas jet, and to them are added 4 ounces of chalk printing ink, and the mixture reduced to the consistency of cream with spirits of turpentine. A soft sponge is saturated with this mixture, and rubbed gently over the exposed paper (in this stage the nature of the grain can be best seen). An ordinary letterpress roller, charged with a little ink from the inking slab, is then passed over the transfer, causing the ink to adhere firmly to the parts affected by the light, and removing it from the parts unacted upon. It will be found that with practice, rolling slowly and carefully as a letterpress printer would his forme, the ink will be removed by the roller according to the action that has taken place by light, leaving the shadows fully charged with ink, and the high lights almost clear, the result being a grained transfer in greasy ink. The transfer is next put into a weak bath of tannin and bichromate of potash for a few minutes, and when taken out the surplus solution should be carefully dried off between clean sheets of blotting-paper. The transfer is hung up to dry, and,

when thoroughly dry, the whole of the still sensitive surface should be exposed to light for about two minutes. A weak solution of oxalic acid should be used for damping the transfer (about 1 in 100), and this should be applied to the back of the transfer with a soft sponge. After it has been damped about four times, it should be carefully put between clean sheets of blotting-paper, and the surplus moisture removed. A cold polished stone is then set in the press, and after everything is ready, the transfer is placed on the stone and pulled through twice. The stone or scraper is then reversed, and the transfer is again twice pulled through. A moderate pressure and a hard backing sheet should be used, care being taken not to increase the pressure after the first pull through. The transfer is taken from the stone without damping, when it will be found that the ink has left the paper clean. Gum up the stone in the usual way, but if possible let the transfer remain a few hours before rolling up. Do not wash it out with turpentine, and use middle varnish to thin down the ink.

“It should have been mentioned that varying degrees of fineness of grain can be given to the transfer by adding a little more ferricyanide of potassium in the sensitising solution, and drying the transfer paper at a higher temperature, or by heating the paper a little before exposure, or by adding a little hot water to the cold-water bath, after the transfer has been fully exposed; the higher the temperature of the water the coarser the grain will be. The finer grain is best suited to negatives from nature, when a considerable amount of detail has to be shown.

“The coarse grain is best for subjects in monochrome, or large negatives from nature, of architecture, etc., where the detail is not so small. Even from the finer grain several hundred copies can be pulled, as many as 12,000 having been pulled from a single transfer, and this one would have produced a great many more if required.”

CHAPTER LI

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

Methods of Obtaining Half-Tone in Phototype Blocks

AN image with a grain suitable for reproduction by phototype having been obtained, the type block may be made by exposing, under a negative taken from this image, a zinc plate coated with bitumen, developing and etching, by transferring a print on transfer paper taken from this negative to a zinc plate and etching, or by using the image, if it be of the nature of collotype, as a matrix, from which a relief block may be cast as in the Pretch process.

These methods of producing type blocks for line subjects have already been described, and of their application to half-tone subjects it should be enough to say that the manipulations are similar.

Asser's Process, described in the last chapter, has been used for the production of type blocks, as explained by Bolas; the image in grain being transferred to a zinc plate and this latter being etched; but the writer is not aware that the process is worked commercially.

By the Collotype Process a grain suitable for reproduction by type blocks may readily be produced. The grain may be made somewhat smaller or closer than is admissible for photo-lithography. Dallas's tint blocks would appear to owe their grain to a collotype or "swelled gelatine" film, but it is impossible to say whether the block is produced by transfer or by reproducing the reticulated surface of the film by electrotype.

The Use of a Grained Screen for Producing a Half-Tone Type Block

As far back as 1866 Messrs. E. and J. Bullock patented a method of interpreting half-tone by a grain, in which they superposed, on a transparent positive, a grained screen, and took a negative from the two together, this negative of course showing, as well as the image of the transparency, the grain of the screen.

It is difficult to account, by any theory, for the fact that the mere *breaking up* of an image by introducing a grain gives the effect of half-tone by a process in which any one point must be represented by either black or white; but this subject has already been touched on in the introductory chapters. Probably the success of the process depends on certain factors—diffraction of light, perhaps, for example—which have not yet been considered in connection with it. At any rate we have nothing to do but to accept thankfully the fact that the result is a very fair representation of half-tone.

The principle of Bullock has been re-patented times out of number, but the only thing in the way of a novelty which has been introduced is the modification of Meisenbach, who introduces an arrangement whereby the grained screen, during the exposure for the reproduction of the final negative from the transparent positive and this screen, is slightly moved once or oftener so as to still further break up the grain. At first sight it would appear that such a movement was the one thing necessary to make the reproduction of half-tone as a black and white grain absolutely hopeless; but it is not at all clear from Meisenbach's own description of his process whether, by this moving, he intended a slight motion in a straight line corresponding only to a half or less than a half of the distance between two lines or dots, or whether he meant the turning of a plate with lines in one direction only, through an angle, so that the lines should be photographed in one direction during the first part of the exposure, in a direction at right angles, or nearly so after moving, and during the second

half of the exposure. In fact, whether it was not merely a means of getting a cross hatching from a set of parallel lines by photographing them twice, once running in one direction, a second time in a direction at right angles. At any rate it is certain that neither one motion nor the other is necessary to the success of the process, and that it would probably be much more detrimental than otherwise.

There are two ways whereby the grain is principally produced: one is the dusting of powdered asphalt on a plate of glass and the warming of this till the powder adheres to the glass. A method of evenly powdering a surface with asphalt will be considered in the next chapter. Another way, and the one most frequently used, is the photographing of something of the nature of netting. Actual wire-netting may be used, or any system of black cross lines on white paper may be photographed. If netting be used, it is photographed against a white background, which may be the sky. By using this method it is, of course, possible to produce a grain of any desired width or number of spots to the inch. A wet plate will be found the best for producing the grained plate.

Processes have been patented in which an actual fine netting of thread is used in contact with the transparency in place of the photographic netting, but it is doubtful if good results can thus be got unless the transparency be made of much larger size than the desired photo block, as the grain will be far too coarse even if the finest netting be used.

All or nearly all the most successful work that is done by the Bullock process, or by modifications of it—whether under the name of Meisenbach or under whatever name—are made from grained negatives produced by the use of a regular graining screen, which may be made in the following way.

The first thing to do is to get or make a set of perfectly ruled lines on a sheet of smooth white paper. If it is possible to get it the best thing is a proof from a copper plate ruled with a machine. The lines must be parallel; they must be considerably thinner than the spaces left between

them, and the number may be about fifty to the inch. In this case the lined sheet should be rather more than twice the size of the largest block that is to be produced. A very good screen can be made from a large sheet of smooth drawing-paper ruled by hand with a drawing pen by any one who is really skilled in the use of such an instrument. In this case, however, it is desirable to make the thing on a large scale with the lines say, $\frac{1}{16}$ of an inch apart. The drawing will in this case have to be seven or eight times larger than the largest block that is to be produced. The hand drawing is not likely to be so fine as the machine ruling, but the amount of reduction being greater, as great perfection may be looked for in the end.

A negative on a wet plate has now to be produced. The scale will depend on various circumstances. Where the screen is to be used next the negative—as will be explained hereafter—the grain must be of the same size as that wanted in the actual picture; when the screen is to be placed in contact with a positive, as will also be explained, it may be on a larger scale. Moreover, the size of grain in the picture itself must be varied according to the nature of the work. Thus, for very fine work the distance apart of the lines of the screen should be but small, and there may be 120 lines to the inch—got by reducing every 12 inches of the machine-lined paper to 5 inches, or every 12 inches of the hand-ruled paper to a little more than an inch and a half in the negative—or even a few more. For average work there may be about 100 lines to the inch got by reducing the machine-lined paper just one-half, the hand-ruled about six times. For rough work there may be fewer than 100 lines to the inch, but the writer is of opinion that when the number is at all much less than that the coarseness of the grain becomes disagreeably pronounced. In any case, however, it is desirable to have coarser screens to use when a photograph is to be reduced, and when the screen is to be placed in contact with a transparency, and it will be found convenient to have a set of screens with grain varying from 150 to the inch to say 25

to the inch. The coarser ones should be made from hand-ruled lines.

The actual screen may be made in the following way :— The paper is mounted quite flat on a drawing-board in the usual way, the board is set up vertically, the camera is placed opposite to it, and the distance is adjusted so that the desired number of lines to the inch is given. We will say that the lines are running horizontally. One-half of whatever is considered the necessary exposure is given, the lens is capped again, and the board is turned so that the lines now run vertically, when the second half of the exposure is given. Care must, of course, be taken that in turning the board its distance from the camera is not at all altered. If the camera have a reversing back the plate may be turned at right angles after one-half of the exposure has been given, instead of the board. Most prefer to have cross lines ready drawn so that no double exposure is needed. The way just described is, in the writer's opinion, the best and easiest for making screens, but from screens made in either way good results can be got, although the nature of the screens differs considerably. By the first method a screen showing a number of square transparent dots results, by the second a number of transparent cross lines.

As has been said, a wet plate must be used for the work. The collodion used should be ripe, the bath fairly acid, and every precaution should be taken to prevent the smallest veil in the shadows. The image should be intensified till it is nearly but not quite opaque.

It is a matter of opinion whether the lines should run parallel with the edge of the plate, or diagonally across it. I consider that the effect is more pleasing when the lines are diagonal.

There are two ways in which a grained negative may be got by the aid of a screen such as that described. The first of these may be called the direct method. It is applicable to such work as the copying of pictures, etc., when the actual object to be copied can be brought to the operator's studio. The only additional apparatus, beyond the grained

screen, that is needed is a reversing mirror or prism fixed in front of the lens. Without this the final picture will be reversed. A wet plate must, as before, be used. It is placed against the silver wires of the dark slide in the usual way, and the screen is placed against the other sides of the wires, so that the surface of the screen will be separated from the collodion film by the thickness of the wires only. In most cases it will be found convenient to make a special slide for this work, with clips for holding the screen in position.

An exposure somewhat longer than would otherwise be needed is now given, and the result on development is a grained negative, which must be made as dense as possible without veiling the shadows.

It would be very easy, using thin plate glass, to arrange that the exposure be made through the glass, the screen being placed in contact with the back, but I have not heard of this being done.

When a block is to be produced from a negative already taken a grained negative is made from the original in the following way. A transparent positive is first taken from the negative by contact, either carbon tissue being used or any dry plate that will give really good quality positives. The grained screen is now brought into contact with the transparency, film to film, and the two together are copied in a copying camera, working in the way by which a negative is commonly made from a positive in the camera. The face of the positive is to be turned to the lens if it have been made by the single transfer carbon process, the back if it have been made on a dry plate. If the operator have not a copying camera he can make the negative by the aid of an ordinary camera, placing the positive in an opening cut in the window or partition of the dark room, illuminating the back of it by a sheet of white paper placed outside the opening at an angle of 45° .

If the grained negative is to be the same size as the original, a screen with a grain of the exact fineness wanted is to be used. If the grained negative is to be smaller, a

screen with a proportionately larger grain—which will, of course, be reduced in copying—is to be used.

A grained negative once made, only care and skill is necessary to make a high relief block from it. The transfer process, the albumen process, or the bitumen process—all of which have already been described—are applicable, but undoubtedly the best results are to be looked for when the bitumen process is used. It is to be observed that a thin and perfectly uniform film is even more essential than in the line process. Also that, in the case of etching an image in a grained half-tone, it is necessary to begin with very weak acids, and to exert the utmost care throughout.

Process of Ives and Analogous Processes

The process of Ives is a very beautiful one, by which work of the very highest excellence is turned out in America. I do not, however, know to what extent it is available to the public, and can only describe the general principles here. The process depends on the pressure of a half-tone relief on a surface more or less compressible, and consisting of a series of slight eminences forming a grain, as, for example, paper having a surface something like bookbinder's cloth. The eminences are flattened out in proportion to the height of the relief, and if by any means the *flattened* portions be inked, the result is a grain representing a half-tone on account of the greater size of the dots or grains in the darker than in the lighter parts. In fact, in the deepest shadows the eminences are entirely flattened, giving an even black tone, in the brightest lights they are not touched at all.

Ives at first used a Woodbury relief, but afterwards he used a gelatine relief (undried) from a transparency, and made a plaster of Paris cast from this (see Chapter XLVII.) A comparatively thin film produces sufficient relief when it is not necessary to resort to drying, and therefore a "swelled gelatine relief" is much more easily produced than a Woodbury relief.

A rubber surface, which has been formed into a series

of V-shaped grooves and ridges, is inked, and is pressed on to the cast. The elastic surface does not touch the hollows. The V ridges are quite flattened out in the highest parts of the relief, producing a continuous black, and everywhere between the deepest and the highest parts they are flattened to a different degree, so as to give an even stipple. The image thus got is photographed, is transferred to zinc, and is etched.

Zuccato's method may be described as a modification of Ives. It is an exceedingly ingenious one. I do not know whether the use of the lead blocks to be described hereafter is open to the public; but if it is, I should put down the process of Zuccato as about the most likely of any to be useful to one taking up the production of type blocks for the first time.

The surface of a piece of lead or of type metal is formed into minute pyramids by planing V-shaped grooves across it in two directions.

A Woodbury relief is produced, the type metal plate is thinly inked, a piece of very thin paper is placed on it, and this is pressed with great pressure between it and the Woodbury relief. The result is that the highest parts of the relief—representing the shadows of the picture—flatten out the pyramids till they are obliterated; they are not touched by the deepest parts of the relief, intermediate parts flatten them to intermediate extents, and a half-tone image is the result on the paper, the half-tone being obtained by dots of varying sizes. This image may be transferred directly to a zinc plate, or may be copied in the camera, a transfer may be made and transferred to the plate, which is then, of course, etched.

Woodbury Process

“Woodbury exposes his ordinary relief under a transparency with a piece of network interposed, the effect of this being to produce a decided grain all over the high portions of the resulting relief and no grain over the deep

parts, intermediate portions being grained to an intermediate extent.”¹

The relief thus obtained is inked up, a transfer is taken from it and is laid down on a zinc block, which is then etched. The network need not be actual netting, but may be a transparent positive of any netlike pattern on a collodion film. It may thus be made as fine as is desired.

There are many other methods of producing half-tone type blocks, but I think I have mentioned the principal.

It is to be observed that much may be done in the etching to help up a type block. Thus a solid shadow may be made anywhere it is required—or even a line if it be thought useful—by treating with bitumen varnish, whilst a high light may be put in by scraping away the protective coating.

¹ Bolas, *Cantor Lectures*.

CHAPTER LII

PHOTO-MECHANICAL PRINTING PROCESSES—*continued*

*Methods of Obtaining Half-Tone in Entaglio Plates*¹

It is to entaglio plates that we have to look for the finest results in photo-mechanical printing. Collotype and even type blocks give results which are in their way excellent, and which are useful for many purposes; but they fall very far short of the results of certain entaglio processes which compare favourably in effect with the very finest hand-engraving, whilst they have the advantage of the accuracy of a photograph.

In prints from type blocks there is always some want, the grain is too conspicuous, there is a want of half-tone,

¹ I notice that Mr. E. Edwards recommends the use of the term "photo-gravure" for entaglio plates or the prints from them, and "photo-engraving" for prints from high relief blocks. There is confusion enough already in the nomenclature of photo-mechanical productions, but that of Mr. Edwards seems to me to make confusion worse confounded. It is applying the word "photo-engraving" to a process that is not an engraving process, and is applying the precise French equivalent to a totally different process. It is true that wood blocks and woodcuts are quite commonly called "wood engravings," but the term is a misnomer. An engraving, in its original and strict sense, is a *cut-in* or entaglio image, or the impression from such. The word engraving came to be applied to wood blocks, because the manipulations in making them were similar to those of engraving. There are, however, no such manipulations in connection with the making of a high relief block by a photo-mechanical process, and the only excuse that there is for the use of the word "engraving" is taken

or of intensity ;¹ but with proofs from entaglio plates it is otherwise. The utmost boldness is obtainable, the gradation of tone is perfect, and although, in a certain sense, a grain or stipple is essential, this may be so fine as to be quite imperceptible. In fact, the slight roughness or removal of polish given by the biting of copper by an etching fluid is enough to give the necessary grain. This was all that gave the grain to the greater number of the engraved plates which were produced by Fox Talbot, and from some of these prints were pulled almost as good as the best that have been made. Since then, however, the best results have been got where some special means have been used to get a stipple somewhat more marked than that got by the mere biting of the plate.

A brief description of the principles involved in various entaglio processes has been given in the second chapter, and it is unnecessary to say anything more of those which are not at the present day practically worked. Unfortunately not very much can be said even of those which have, because, as in the case of the production of type blocks, the greater number of workers of processes have kept secret those small details of practice which make success possible in place of failure, even when they have

away. An entaglio plate may, without impropriety, be called an engraving, inasmuch as, although no actual engraving work is done in connection with it, it is an imitation by photo-mechanical means of what is undoubtedly an engraving. "Phototype" is certainly not a pretty word, but it is at least correct when speaking of high relief blocks. One objection that I have to the term "photo-gravure" is that a foreign word or phrase should never be used when there is an English equivalent—when speaking or writing English, of course, I mean. I know of no precise English equivalent for "entaglio," or I should not use the latter word.

¹ The improvement that has taken place in the production of phototypes, especially in France and in America since the above—which was printed in the first edition—was written, has been so great that the statement is certainly no longer true of the highest class of work turned out, which appears to leave but little improvement possible. Still, there is that in a copper-plate engraving that cannot be equalled by a print from any kind of high relief block.

published the general principles of the processes, which they have not always done. Again, where details have been published, they, with the processes, have generally been patented, and they are therefore not open to the public.

Several processes for the production of entaglio plates are open to the public, and fortunately of one of these, and that one which gives results equal to any, working details have recently been published. It must not, however, be expected that even when details are published success in working an entaglio half-tone process can be gained but by long and patient practice. The manipulation of a plate by such a process is a matter of the utmost delicacy at every turning.

Before describing any processes used exclusively for the production of half-tone entaglio plates, I should mention that every process used for obtaining half-tone in type blocks has probably been at one time or another applied to the production of the same in entaglio copper plates, and that at the present time the Meisenbach principle is used for the purpose. The writer has seen very successful prints from copper plates, in which the grain was produced by this process, made by Mr. E. Edwards; but he cannot help saying that he considered them to fall very far short of prints from plates produced by the same operator by a different process (Klic's). A great deal, however, depends on taste.

I must here remind readers that for the production of a half-tone entaglio plate, something more than mere depth is needed in those parts that are to represent the deepest shadows. Were this all that is needed, a mould from a Woodbury relief or a reproduction of a Stanotype plate would make the most perfect entaglio plate. The many attempts that have been made to produce entaglio plates by merely electrotyping a swelled gelatine relief would appear to indicate that many who have worked to produce half-tone entaglio plates have not understood the requirements.¹ In line work mere depth is sufficient to produce

¹ I do not refer here to the experiments of Pretch and others, who took advantage of the reticulation of gelatine to obtain a tooth or grain.

blacks, but in half tone work something more is needed. As Mr. E. Edwards has somewhere very neatly put it, the shadows should be of a honeycomb-like construction, the cells holding ink so that it cannot be removed by any mere rubbing motion, but will be taken up by the paper when the latter is pressed down with such force that it is pressed into the cells.

Talbot's Process

This process, as actually worked, not as described in Talbot's patents, is probably the simplest of all photo-engraving processes, and is, at the same time, one capable of giving excellent results *in the case of some subjects*, and good results in the case of any, if the photographic and chemical work be supplemented by sufficient hand-work—a thing doubtless, however, that might be said of pretty well any process.

The following are the details of the process :—A copper plate has first of all to be coated with a thin and even film of bichromated gelatine. No substratum is needed, and the formula given for making the sensitive compound for Husnick's collotype process may be used (see Chapter XL. p. 330). The plate must be thoroughly polished and cleaned. It may be coated by hand, but it is better to use a whirling table. In this case whirling is continued till the gelatine has set; the plate is then put on one side to dry. The drying is to be done at the ordinary temperature—that is to say, at a temperature not exceeding 75° Fahr., better not exceeding 70°. No special drying box is needed. The film may be dried in any room that is well ventilated and that is fairly well protected from actinic light. The conditions of drying are pretty much the same as these for carbon tissue. Unless the film be too thick, the time taken at an average temperature will be three or four hours.

A transparency of the subject is needed. This must not be reversed, and, therefore, the single transfer carbon process is not available. Any process that gives a direct transparency by contact may be used, or the transparency may be made in the camera by the wet process. The last-

mentioned method is the best where the size is to be reduced.

The film-covered copper plate is now to be exposed in an ordinary printing-frame in contact with the transparency. It is impossible to say how long an exposure will be found necessary, as this will, of course, vary with the density of the transparency—which should be brilliant, but by no means hard. It may be said that the exposure will be about twice what would need to be given to a collotype plate in the same light.

The exposure over, the etching is to be done. For this there is necessary a quantity of perchloride of iron dissolved in water to make a saturated solution. Of this saturated solution two parts are taken, and one part of water is added. This is poured over the surface of the copper plate, and is kept moving to and fro as in developing a gelatine plate. A perchloride of iron solution has the peculiarity that, etching through a gelatine film, it acts more rapidly the more—within limits—it is diluted. If the action be very slow, or if the plate does not begin to etch at all, the fluid is poured off, a little water is added, and it is poured on again. The action can readily be seen through the film and it should be continued, adding a little water from time to time as may appear necessary, till the high lights are just slightly affected.

The gelatine film is now to be removed by the application of a strong solution of caustic potash, when the plate is ready to be printed from, or to go to the hands of an engraver to receive whatever retouching it may need. It will be observed that it is recommended to continue the action till *even the highest lights are slightly etched*. This is not advisable in all cases, but it is in most. If the etching be so continued there will be no absolutely white high lights. If these are needed they must be put in by hand, by polishing the parts of the plate to represent them with a burnisher.

The faults of this process will be evident if a few moments of consideration be given to it. It will be seen that, in the case of large areas representing deep shadows,

there is nothing beyond the slight roughness of the copper due to the etching action to hold ink, and this is not enough for any depth of shadow. The higher lights and the half tones, to a certain limit, are well represented, but all darker than certain rather light tones are represented by a uniform tint, unless the surface be considerably broken up so that the ink is not rubbed up in clearing the plate.

It may be said that the subjects that are best rendered are those in which there are no large areas of deep shadow and in which the half lights and less intense shadows are, if one may be allowed the expression, naturally broken up into a stipple. To illustrate what I mean, I would ask the reader to consider a photograph of a grassy bank or of a sunlit laurel tree. There may be general impressions of shade produced, but, if the photograph be looked closely into, it will be seen that these are almost entirely made up of varying proportions of two tones. One may take as the converse of this the case of a large female head with delicately-modelled high lights and half tones, and with deep shadows. The first is a subject that specially lends itself to rendering by almost any photo-mechanical process, the second is one that taxes the capabilities of the best.

It must always be borne in mind that, even if it is necessary to go over a considerable proportion of a copper plate by hand, the labour is not so great as might be expected, as the photo-mechanically done work, however poor it may be, serves as a guide to the engraver.

Clic's Process

By this process, which, it will, be seen is a modification of Talbot's, the very finest results have been got. It is worked with great success in Glasgow by Annan Brothers; in Brooklyn, United States, by Mr. E. Edwards; and by various operators on the Continent. Some of the results obtained by this latter the writer considers to be at least equal to anything that has been done in the way of photo-mechanical reproduction. Various details of working have

been published, the most complete having appeared in the *Photographic News*.¹

The following are the general principles of the process :—

A copper plate is covered with a fine powder of asphalt, which is caused to adhere by heating the plate, on this plate is developed a carbon *negative*, made by exposing a piece of tissue under a positive, and the whole is placed in an etching fluid. The powdered asphalt gives the grain, and the carbon negative permits the etching fluid to bite to a depth inversely proportionate to the thickness of the gelatinous film. It will be seen that the process differs from Talbot's chiefly in the introduction of the asphalt powder to produce a grain.

The practical details of the process are as follows :—

The copper-plate is polished and is cleaned with whiting mixed to about the consistency of cream, and with some caustic soda added.

The cleaning must be continued till, when the plate is rinsed with water, the water spreads evenly over it, not running in patches. This indicates that the last trace of the oil used in polishing has been got rid of.

The plate has now to be covered with a fine powder of asphalt. There are various ways of doing this. In any case the asphalt must be first of all reduced to a fine powder. Mr. Ernest Edwards has told me that he covers his plates with powder simply by holding them in a shower of the dust allowed to fall through the air.

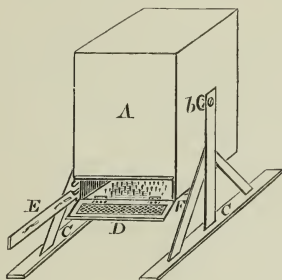
The following is the description given in the *Photographic News* of the more elaborate method of Delechamp's—a box revolving on an axis is used :—

“To make such a one, get a well-seasoned wooden box, about 4 feet high, dove-tailed and joined without crevices, including the top, which must be made a fixture; the internal dimensions of the bottom must be large enough to carry the largest sized plate to be etched, and the inside had better be French-polished, or papered with a surface-glazed paper. At one of the sides close to the

¹ *Photographic News*, January 28, 1887.

bottom make a narrow door, hinged to the bottom of the box. It should be framed and panelled to prevent its warping.

“To ensure the operator from being ‘powdered,’ nail strips of sheet-rubber round the inside of the door, so that it will shut up nearly hermetically ; use a bar with a stout spring or screw to close it, as in a copying-frame, then a few double-pointed nails driven into the base upon which the powder is settling will complete the affair, with the



exception of the axis, which will be better understood from the foregoing sketch."

To powder the plate the following operations are gone through :—

“A quantity of finely powdered asphalt or resin having been placed in the box, the door is closed tightly, and it” (the box, not the door) “is turned over two or three times to shake up the powder. After the lapse of a minute or two, to allow the coarser particles to settle down, the door is opened and a previously cleaned plate is placed therein” (in the box, not the door), “poised on the points of the nails (which should project 1 inch from the bottom and all be equal in height), and the door is closed. Shoot the bolt F to keep the apparatus steady after having revolved it.

“The degree of granulation is entirely in the hands of the operator, as the longer the plate remains in the box the greater will be the quantity of powder deposited, and the finer will be the resulting grain, as there will be less

surface exposed to the action of the mordant" (etching fluid).¹

The plate is now heated in the flame of a Bunsen burner till the dull surface of the asphalt changes to a glossy coating; at this moment the plate is removed from the flame.

A transparent positive is made on glass in any of the various ways by which such positives can be produced. This positive must be reversed. It can therefore be most conveniently made by the carbon process (see Chapter XXXII. p. 246). A piece of ordinary carbon tissue is exposed under this positive, is squeegeed on to the copper plate on which has been laid the grained asphalt surface, and is developed in the usual way. The colour of the tissue is of no consequence, but it is advisable that there be but little pigment, so that the progress of the etching can be seen through the film.

The etching fluid is a solution of perchloride of iron. As has been already stated, such a solution acts less vigorously when saturated than when diluted. Four solutions are made up; the strongest is made so that it has a specific gravity of 40° Bennie, the weakest so that it indicates 30°, and the others of intermediate strength. In each solution a strip of copper is placed till the solution perceptibly changes colour. If this precaution be omitted the solution may act unevenly.

The edges and back of the plate are varnished. The fluid may be kept on the plate either by building a wall of wax round the part that has to be etched, or by flowing it (the fluid) over the plate in a dish.

The solutions are all used at a temperature of about 70° Fahr.; the strongest first, and after that the weaker ones in succession. The action can be watched through the

¹ Further than this, it is greatly under the control of the operator by waiting for a shorter or longer time after turning the revolving box and before inserting the plate. In some cases, where the very finest possible grain is wished, it may be desirable to wait about ten minutes after inserting the plate, and to repeat the powdering two or three times.

film, and experience will show how long to let the various solutions act.

Instead of making up the solutions as just described, a single solution gradually diluted from a saturated solution, as described for the Talbot process, may be used. The remarks made, in the description of that process, as to etching till the high lights are just affected, etc., apply also to the process at present under consideration.

The gelatinous image is removed with caustic alkali, and the asphalt with turpentine.

The writer has, working just as described, produced plates that would give quite passable prints in the hands of a really skilful copper-plate printer, but usually, unless re-etching be resorted to, although the gradation of tone may be perfect, there is a lack of depth in the shadows. The manner of re-etching is as follows :—The gelatine is removed but not the asphalt graining. The A resist ink, such as that described at the end of the chapter on entaglio engraving in line (Chapter XLVIII. p. 379), is used with a polished roller. The roller is so applied that the higher lights only are covered. It is advisable to strengthen the resist by powdering with resin and heating till the resin is incorporated with the ink. It is to be observed that no harm will result if the resin be not quite completely removed from the rest of the plate so as what remains is not irregularly spread over its surface.

The plate is now re-etched for about a minute in a mixture of equal parts of a saturated solution of perchloride of iron and of water. The resist varnish is applied a second time, this covering somewhat more of the details, and a second etching similar to the first is given. This operation may be repeated three or four times or even oftener, but it is necessary to watch the effect very closely. The great danger is that the asphalt in the deepest shadows be under-cut, and that the grain be thus destroyed, the parts that should show the strongest grain being thus rendered comparatively smooth. The shadows should be examined after each etching with a powerful magnifier, and it is advisable, if any tendency towards the defect mentioned

be observed, to stop all further etching, and get any additional depth that may be needed in the shadows by hand-work.

Woodbury's Process

Woodbury, as was usual with him in all photo-mechanical processes, was to the front with a really practicable engraving process. The general principle of his process has been described in the second chapter. It will be understood since the method of getting a Woodbury relief has been described. Such a relief is used, powdered glass, or some other gritty powder, being incorporated with the gelatine. The relief is then pressed into a sheet of lead. Lead is too soft to print from, and the surface is therefore reproduced in copper. One way of doing this is by depositing copper on the lead plate by the electrotype process till a copper film of sufficient thickness to be manageable is obtained. On this, in its turn, is again deposited a copper film.

One very beautiful detail of the invention, intended to ensure a stronger grain in the shadows than in the high lights, is the use of a tissue for the production of the relief, made up of a series of layers containing gritty matter of gradually-increasing fineness from the lowest upwards. I do not know whether or not this idea has been made use of in practice.

It is said that the magnificent photo-gravure prints issued by Goupil and Co. of Paris are produced by this process. They have never been excelled by anything of the kind ; but it is said that a great deal of hard work is necessary before the plates are fit to be printed from.

The Waterhouse Process

Sand is waxed by placing it in an iron pot, heating it, placing some wax amongst it, removing from the source of heat, and continually stirring during cooling.

A carbon print is produced on a surface of silvered

copper by exposing a piece of tissue under a reversed negative, and developing it on the plate. The plate after development is placed in a falling shower of the waxed sand. It is dried, and the sand is brushed away. Small pits are left, forming a "discriminating grain." The surface is blackleaded, and a cast is made from it in an electrotype bath. This cast is the printing plate.

Sawyer's Process

In this process carbon tissue is used in which the pigment is replaced by powdered graphite. The developed picture is thus a conductor of electricity, and a cast can be made direct from it by electrotype. All that has been published about the process can be read in the *Transactions of the Photographic Society of Great Britain*.¹

Obernetter's Process

The principle of this process has already been described, but the writer is unable to give working details at the time of writing. The process is an exceedingly ingenious one, and likely, in the hands of skilled workers, to be very successful.

¹ See *Journal of the Photographic Society of Great Britain* for November 1885.

CHAPTER LIII

THE PRODUCTION OF TRANSPARENCIES OR TRANSPARENT POSITIVES

THE subject of transparent positives has been incidentally mentioned more than once in the foregoing chapters, but I think a few words on the subject generally are called for in a book on Printing Processes.

Transparent positives are generally produced for one of three different purposes, either as an intermediate step in some process—as, for example, the powder process—as pictures to hang against windows or in suchlike positions for ornamental purposes, or for lantern slides. The qualities necessary for these different purposes vary somewhat.

Thus when a transparency merely serves an intermediate purpose, it is generally necessary to secure all the *high light details* in great strength, and it is almost impossible to do so without giving such an exposure that even the highest lights are slightly veiled. This necessitates slightly denser shadows than would be necessary with perfectly clear high lights, so as to retain contrast, and, in fact, a transparency used merely as a means for reproduction of negatives or positives should, as a rule, be generally somewhat darker than is pleasing to the eye.

In the matter of a transparency for decorative purposes we must be guided entirely by taste. The transparency is in this case the finished picture, and should be made, as regards density, colour, and so forth, as the artistic knowledge of the operator dictates.

In transparencies for the lantern the matter is slightly different, and for the following reasons:—A veil in the high lights, scarcely visible when the slide is looked at merely as a transparency, will entirely destroy the brilliancy of the image produced on the screen. Again, the contrast on the screen always appears greater than that of the slide looked at against a light as a transparency. For these reasons it is necessary to secure, in lantern slides, the most perfect transparency of high light and the extremest delicacy of image. Any process that will produce a good lantern slide is certainly good enough for the production of a transparency for any purpose. I therefore say a few words first on the methods applicable to the making of such slides.

Various of the processes already described are well suited to the production of lantern slides, notably the *Carbon process*, the *Woodbury-type*, and the *Stannotype* processes, an essential condition for success with the two last-mentioned processes being the use of glass that is quite flat.

The *wet collodion* process and the *collodio-bromide* are both exceedingly useful for lantern-slide work, but it is beyond the scope of this work to consider them in detail.

Gelatino-chloride plates have recently become very popular for lantern-slide work. Such plates are now a recognised commercial article. The exposure needed with them is considerable, amounting to many hundred times that necessary for gelatino-bromide plates. By contact a second or two to diffused daylight may be given, or a few inches of magnesium ribbon may be burned at a distance of a foot or so—less or more, according to the density of the negative and the colour of transparency wished—from the negative. The exposure to lamplight is very long, amounting to perhaps quarter of an hour at a foot from an ordinary burner. It is, however, quite within reasonable limits if a bright light such as an albo-carbon burner or a duplex paraffin lamp be used.

A very great range of colour is obtainable with gelatino-chloride. It is possible to get anything from an engraving

black to claret colour according to exposure and development.

The developer is ferrous oxalate, ferrous citrate, or a mixture of the two. With a comparatively short exposure and ferrous oxalate a black colour is got, with a long exposure and strongly acid ferrous citrate a red colour, and anything between these two limits with intermediate exposures and mixtures of these developers. Instructions for compounding the developer in the various ways issued are sent with the plates.

The films of gelatino-chloride plates are very transparent, and on account of their comparative insensitiveness a good deal of artificial light may be used in development, and it is therefore easier to regulate the density than in the ordinary bromide plates.

Very slow gelatino-bromide plates give excellent transparencies. The writer has found it possible, by using plates of about the same sensitiveness as a wet plate, made with a pretty ripe collodion, to get a great variety of tone. He used a pyro developer with carbonate of potash and sulphite of soda—such a developer as Beach's. To get a black tone he gave a moderate exposure, and used the developer only slightly weaker than it would be used for negative work, and with a little restrainer. To get a claret colour he gave an exposure about fifty times as long as the shortest that would serve, increased the pyro of the developer, added several grains of bromide of ammonium to each ounce of solution, kept the amount of alkali low, and continued development for a long time. Exposures between the extremes, with the developers properly adjusted, gave all varieties of tone from black to claret colour.

Plates such as those just described, although slow, are much more rapid than gelatino-chloride transparency plates.

Hydrokinone has recently come to be much used for the development of transparencies. It gives a very rich black colour, with great clearness of high lights.

Any of the processes before mentioned may be used for making ornamental transparencies. But for transparencies needed for the reproduction of negatives, the powder pro-

cess, etc., a somewhat prolonged exposure would be generally advisable.

Certain paper processes give very good results in ornamental transparencies of large size. Thus if a print be made on gelatino-bromide paper, a somewhat longer exposure being given than for an ordinary print, and if the finished positive be treated by smearing the back of it with oil-vaseline, be laid on one side for twenty-four hours, and the excess of vaseline be then removed with a clean cloth, a very effective window transparency will result.

Even common albumenised paper sensitised in the usual way may be used for such transparencies, the *back* of the paper being placed in contact with the negative, and exposure being continued till the desired effect is seen on looking *through* the paper.

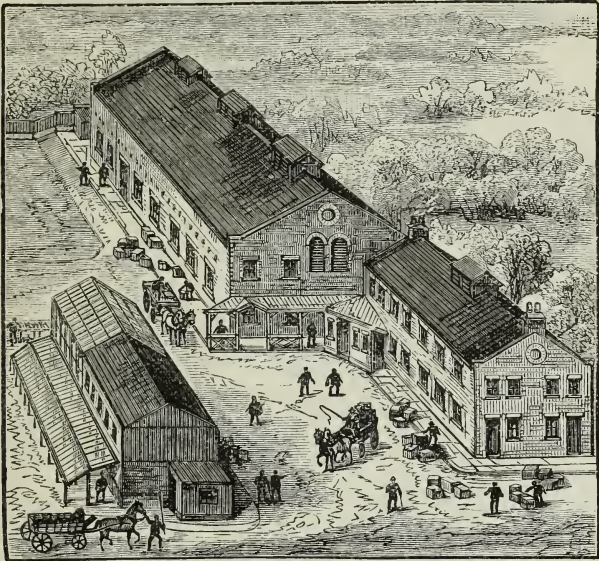
The slower makes of ordinary gelatino-bromide plates intended for negative work will make quite presentable transparencies if developed with a considerably diluted and well-restrained ferrous oxalated sulpho-pyro or hydrokinone developer.

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From their cheapness and excellence are in universal use.

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With Revised Formule and Instructions for Use.

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Sizes.	Per Doz.	Per Doz.	Per Doz.	Per Doz.
1 $\frac{1}{4}$ × 1 $\frac{1}{4}$	1/	1/3	1/6	...
2 × 2	1/	1/3	1/6	...
3 $\frac{1}{4}$ × 3 $\frac{1}{4}$	1/	1/3	1/6	...
3 $\frac{1}{4}$ × 2 $\frac{3}{8}$	1/	1/3	...	...
4 $\frac{1}{4}$ × 3 $\frac{1}{4}$	1/	1/3	1/6	1/6
5 × 4	1/7	2/	2/6	2/6
6 $\frac{3}{4}$ × 3 $\frac{1}{4}$	2/2	...	...	...
6 $\frac{1}{2}$ × 4 $\frac{1}{4}$	2/2	2/9	3/3	3/3
6 $\frac{1}{2}$ × 4 $\frac{3}{4}$	2/3	3/	3/8	3/8
7 $\frac{1}{4}$ × 4 $\frac{1}{2}$	2/10	...	4/10	...
7 $\frac{1}{2}$ × 5	3/5	4/6	...	4/10
8 $\frac{1}{2}$ × 6 $\frac{1}{2}$	4/3	5/6	6/6	6/6
9 × 7	5/	6/6	7/6	7/6
10 × 8	7/3	9/6	11/	11/
12 × 10	10/	13/	16/	16/
15 × 12	18/	23/	28/	28/
16 × 11	18/6	23/6	29/	29/
16 × 12	21/6	27/	33/	33/
16 × 13	22/	27/6	35/	35/
16 × 14	24/	30/	38/	38/
17 × 11	22/	28/	38/	38/
17 × 12	23/	29/	40/	40/
17 × 13	24/	30/	42/	42/
17 × 14	26/	33/	44/	44/
18 × 16	37/	45/	53/	53/
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Sizes. In Centimetres.		Per doz. s. d.	Per doz. s. d.	Per doz. s. d.
9 × 12	.	1 3	1 6	1 11
11 × 15	.	2 2	2 9	3 3
12 × 16½	.	2 3	3 0	3 5
12 × 20	.	3 5	4 6	5 2
13 × 18	.	2 6	3 4	3 9
18 × 24	.	5 0	6 8	7 6
21 × 27	.	9 0	11 6	13 6
24 × 30	.	10 0	13 0	15 0
26 × 32	.	13 6	17 0	20 3
30 × 40	.	21 0	25 0	32 6
50 × 60	.	80 0	90 0	120 0

RAPIDITIES OF MARION'S PLATES.

Each box is marked with Hurter and Driffeld's Inertia and Actinograph number.

* *Caution.*—Be not misled by high Sensitometer numbers. Our **Instantaneous** for rapidity will be found superior to most makes, but certainly inferior to none.

The **Ordinary**, in well-lighted studio, using Lens F/4, require one second of exposure.

The **Rapid**, in well-lighted studio, using Lens F/4, require $\frac{2}{3}$ of a second.

The **Instantaneous**, in well-lighted studio, using Lens F/4, require $\frac{1}{2}$ of a second.

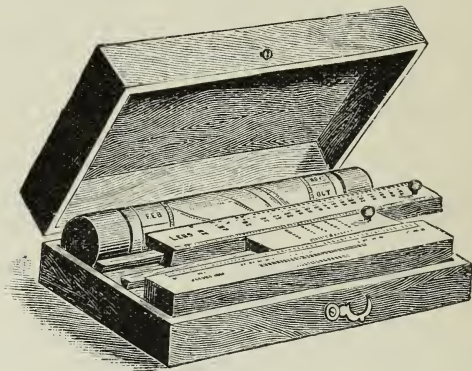
Or for Landscape work, open, well-lighted, using Lens F/8—the **Ordinary**, $\frac{1}{8}$ of a second; the **Rapid** $\frac{1}{11}$ of a second; the **Instantaneous**, $\frac{1}{16}$ of a second.

MARION & CO., 22 & 23 Soho Square, London, W.

IMPORTANT NOTICE.

Marion and Co.'s Dry Plates are now being issued with an absolutely correct exposure number on each box. This number, denoting the rapidity of the plate, is obtained by the Hurter and Driffield system, which from repeated and exhaustive experiments we find to be thoroughly reliable. The time of exposure for any day of the year, or for any hour of the day, is found by referring to the corresponding number of Hurter and Driffield's Actinograph, which we supply at a moderate price.

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PRICE 10/6.

THE Actinograph is an instrument for calculating the necessary exposure, in the camera, on photographic plates, and we place it before the photographic public confident that it will be found to supersede any previous effort to facilitate such calculations. And as we hold that the production of a technically perfect negative is absolutely dependent upon an accurate exposure, we have every reason to hope that the Actinograph will supply one of the most pressing photographic needs of the day.

It must be distinctly understood that each Actinograph can only be used with accuracy within a certain range of latitude north or south of that marked on the instrument. The Actinograph provided with light-diagram for north latitude $52^{\circ} 30'$ is no doubt sufficiently accurate for the whole of England and Ireland, but it would become more and more unreliable as we go farther north and south of this latitude. As, however, its unreliability would be chiefly felt in the earlier and later hours of the day and in the winter, the Actinograph will serve for a more extended range of latitude if the photographer confines his work to the middle of the day and to the summer months.

Actinographs may be specially ordered with light-scales for any desired latitude.

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(VIOLET LABEL.)

For Lantern Slides.

MARION & CO., Sole Proprietors.

Specially prepared for making Transparencies, or Lantern Slides, in the Camera, or by Contact printing with gas or other artificial light, also eminently suitable for reproduction of Negatives and general copying purposes.

Sizes.	Per. Doz.	Sizes.	Per Doz.
$3\frac{1}{4} \times 3\frac{1}{4}$	1/	$8\frac{1}{2} \times 6\frac{1}{2}$	4/3
$4\frac{1}{4} \times 3\frac{1}{4}$	1/	9×7	5/
5×4	1/7	10×8	7/3
$6\frac{1}{2} \times 4\frac{3}{4}$	2/3	12×10	10/
$7\frac{1}{2} \times 5$	3/5	13×8	10/
$8\frac{1}{2} \times 4\frac{1}{4}$	3/9		

Any other Sizes to order charged in same proportion.

THESE Plates are much slower than the ordinary Bromide used for Portrait and Landscape work, but much quicker than the pure Chloride Plates ; in the Camera they will be found to give, with full exposure, very brilliant images with clear glass in the unexposed parts, making them specially valuable for general copying purposes and making Lantern Slides.

COWAN'S GELATINO-CHLORIDE PLATES.

(GREEN LABEL.)

For Lantern Slides.

Sizes.	Per Doz.	Sizes.	Per Doz.	Sizes.	Per Doz.
$3\frac{1}{4} \times 3\frac{1}{4}$	1/	$7\frac{1}{2} \times 5$	3/5	10×8	7/3
$4\frac{1}{4} \times 3\frac{1}{4}$	1/	$8\frac{1}{2} \times 4\frac{1}{4}$	3/9	12×10	10/
5×4	1/7	$8\frac{1}{2} \times 6\frac{1}{2}$	4/3	15×12	18/
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THESE Plates in appearance differ entirely from the usual Bromide films, being very transparent, and of a deep orange colour by transmitted light, but are capable of development to any density required.

Though extremely sensitive to daylight, they are much less so to gaslight ; so that more artificial light may be used during development than with Bromide Plates. This will be found to be of great advantage, as the Plates may be examined from time to time within a reasonable distance of a gas-flame, and the density thus regulated to a great nicety.

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So perfect are the tones, and so clean and even the emulsion, that very little artistic work is required to make a finished picture.

Plates.— $4\frac{1}{4} \times 3\frac{1}{4}$, 3/6 per doz.; $6\frac{1}{2} \times 4\frac{3}{4}$, 7/6; $8\frac{1}{2} \times 6\frac{1}{2}$, 13/; 10×8 , 16/;
 12×10 , 26/; 12×15 , 40/.

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PRICES.

Sizes.		Per doz.	Sizes.		Per doz.
$4\frac{1}{4} \times 3\frac{1}{4}$	.	3/	10×8	.	22/
$6\frac{1}{2} \times 4\frac{3}{4}$	.	7/4	12×10	.	32/
$8\frac{1}{2} \times 6\frac{1}{2}$	.	16/6	15×12	.	56/

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Eikonogen, manufactured by the Actien Gesellschaft für Anilin Fabrikation and for whom we are sole English Agents. It has come to be acknowledged as the best and most powerful of all developers, and for amateurs, there is this advantage, it can be used without any soiling of the hands. *Sold as follows*—Eikonogen Cartridges already mixed with the necessary sulphite and carbonite, and only requiring the addition of about 7 oz. of water, when it is dissolved it is quite ready for use and will serve for several plates. In this form it is most convenient for all travellers; in fact, let the Amateur once try it and he will always be in favour of this marvellous developer.

Eikonogen Cartridges ready mixed for dissolving in water, 10 cartridges in a box, 3/.

Eikonogen Solution in two 20 oz. bottles ready for mixing, 3/ for the two bottles. Eikonogen in powder (this is in its concentrated form and for mixing with Sulphite of Sodium and Carbonate of Soda, the formula must be followed), in 1 oz. Tin $1/2$, $\frac{1}{20}$ of a Kilo $1/9$, $\frac{1}{10}$ of a Kilo 3/, $\frac{1}{4}$ of a Kilo 6/6, $\frac{1}{2}$ of a Kilo 12/6.

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Marion's Universal 10 per cent Developing Set. The advantages of 10 per cent Solutions are, that the greatest accuracy can be secured in large or small quantities with the least possible trouble and without the use of scales and weights, and also that it serves for all makes of plates. The ordinary set is, Pyro and Ammonia put up in a neat case and containing all the necessary Solutions, bottles and measures, and will be found sufficient to develop 100 half plates.

Other Developers can be supplied in 10 per cent Solutions, such as—

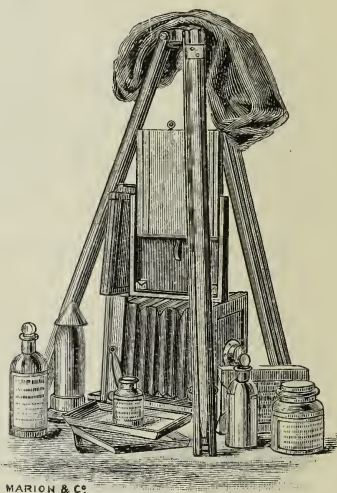
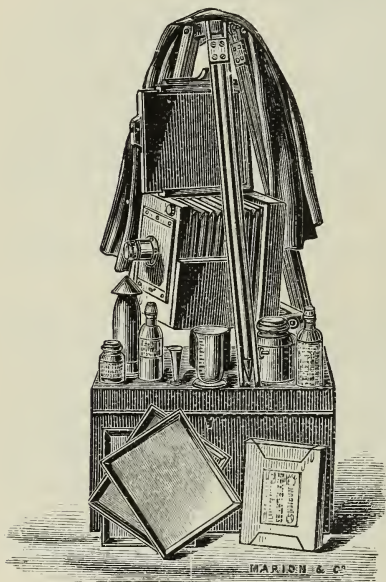
Pyro and Meta-bisulphite of Potass, 2/10. Hydrokinone in Alcohol, 3/6. Sodium Sulphite, 1/. Potass, Meta-bisulphite, 1/6. Sodium Carbon Crystal, 1/. Potass Carbon Crystal, 1/3. Sodium Hydrate, 1/3. Potass Hydrate, 1/2.

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The A.B.C.	$4\frac{1}{4} \times 3\frac{1}{4}$	.	.	.	.	2 5 0
The Student's	5×4	.	.	.	.	2 10 0
The Oxford	$6\frac{1}{2} \times 4\frac{3}{4}$	.	.	.	.	5 0 0
The University	$8\frac{1}{2} \times 6\frac{1}{2}$	.	.	.	.	10 0 0
The Engineer's or Builder's for	12×10	.	.	.	.	22 0 0

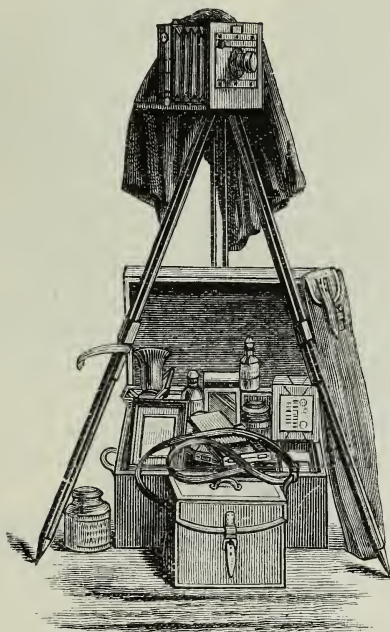
COMPLETE PRINTING SETS FOR THE ABOVE.

The Nonpareil	.	.	.	.	.	£0 12 6
The A.B.C.	.	.	.	.	.	1 3 0
The Student's	.	.	.	.	.	1 5 0
The Oxford	.	.	.	.	.	1 10 0
The University	.	.	.	.	.	2 0 0

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"	"	$6\frac{1}{2} \times 4\frac{3}{4}$	.	.	.	.	17	0	0
"	"	$7\frac{1}{2} \times 5$	.	.	.	.	18	10	0
"	"	$8\frac{1}{2} \times 6\frac{1}{2}$	.	.	.	.	20	0	0
"	"	10×8	.	.	.	.	28	0	0
"	"	12×10	.	.	.	.	34	0	0

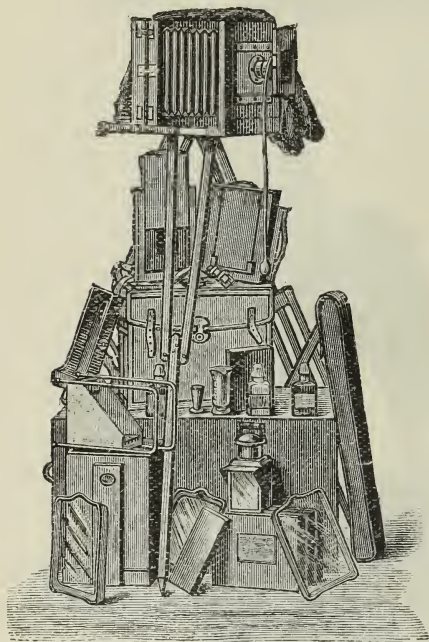


MARION & CO

Superior Printing Set with Stock of Material,			$4\frac{1}{4} \times 3\frac{1}{4}$	.	£1	10	0
”	”	”	5×4	.	2	0	0
”	”	”	$6\frac{1}{2} \times 4\frac{3}{4}$	.	2	5	0
”	”	”	$7\frac{1}{2} \times 5$	.	2	10	0
”	”	”	$8\frac{1}{2} \times 6\frac{1}{2}$	.	3	0	0
”	”	”	10×8	.	4	5	0
”	”	”	12×10	.	5	0	0

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		(Whole Plate)	Photo Set.			Printing Set.		
			£	s.	d.	£	s.	d.
For Plates	$8\frac{1}{2} \times 6\frac{1}{2}$		37	0	0	3	0	0
" "	10×8		45	0	0	4	5	0
" "	12×10		55	0	0	5	0	0

From A. ERNEST AYERS, Esq., Imperial Chambers, King William Street, Adelaide.
 —“Gentlemen . . . I have now given my Camera and Lenses a thorough trial, and they have proved very satisfactory; the Camera is far superior to anything I have seen, and will I think stand any climate. The Stand is very strong and most convenient; my negatives are pronounced excellent, and all are a very good colour. I am very pleased with both Lenses; they give excellent definitions.”—*April 8, 1889.*

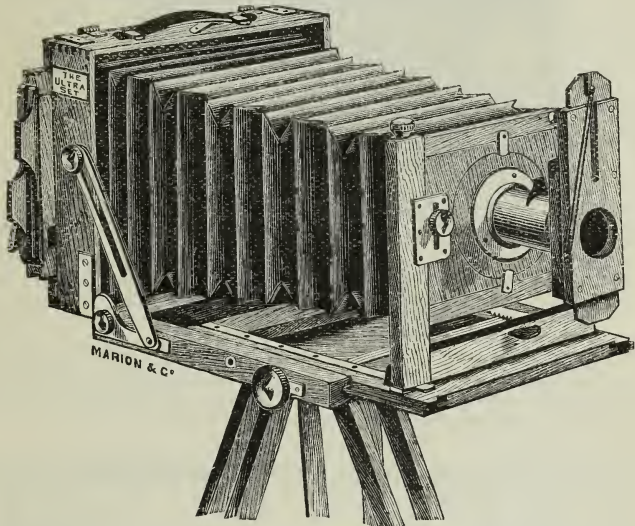
MARION & CO., 22 & 23 Soho Square, London, W.

THE NEW CAMERA.

For Plates $6\frac{1}{2} \times 4\frac{3}{4}$ with one double back and a strong folding Tripod Stand, a very cheap and well made Camera	£3 15 0
Extra double backs	0 10 6
A choice of { Marion's United Lens Rectilinear form	1 1 0
Lenses. { The Soho Lens, a very superior article	3 3 0
{ Voigtländer's Medium rapid Euryscope	4 12 0

The New Complete outfit, with Chemicals, Dishes, Plates, and everything complete for making Negatives , and also Apparatus and everything necessary for printing	7 0 0
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THE ULTRA CAMERA.



A very light, strong Camera in good Mahogany, Leather Bellows, long or short Focus, Double Swing, Rising Front, Rack Adjustment. Folds up very compact. With 3 Double Backs.

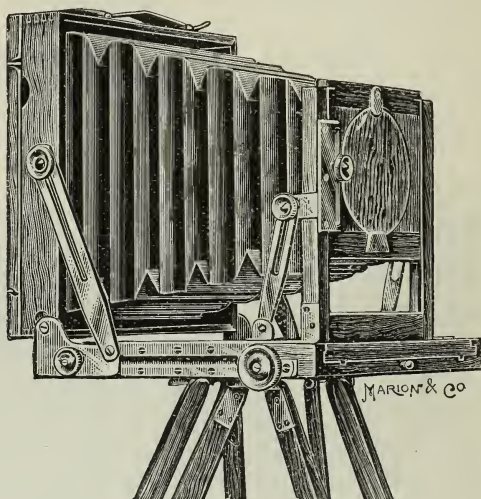
FOR PLATES

FRENCH SIZES.

	$6\frac{1}{2} \times 4\frac{3}{4}$ No. 507	$8\frac{1}{2} \times 6$ No. 508	9 X 12 cent. No. 528	18 X 13 cent. No. 529	24 X 18 cent. No. 530
Ultra Camera and 3 Backs	113/	150/	114/	130/	182/
No. 601. Good Rectilinear form of Lens	21/6	35/	21/6	25/	35/
(Extra for M. and Co.'s Superior Rectilinear form of Lenses, $\frac{1}{2}$ pl. 39/6, $\frac{1}{4}$ pl. 36/.)					
No. 901. Waterproof Case	7/6	10/	6/	7/6	10/
„ 701. Tripod Stand	15/	15/	12/	15/	18/
„ 801. Pneumatic Shutter	7/6	10/	7/6	7/6	10/
	164/6	220/	161/	185/	255/

MARION'S "PERFECTION" CAMERA.

Highly Finished and of Best Quality Mahogany



A very strong and yet very light Camera. A very short focus, with no bottom board projecting; yet it has a very long focus when racked out. Rising and swing front, double swing back. Patent turntable for fixing stand to. Every desirable movement has been provided for in the most practical way.

Prices complete, with Three Double Backs, and with Folding Ash Tripod.

For plates	$6\frac{1}{2} \times 4\frac{3}{4}$	.	.	.	.	.	.	.	£8 5 0
„	$8\frac{1}{2} \times 6\frac{1}{2}$	.	.	.	.	.	.	.	9 15 0
„	10×8	.	.	.	.	.	.	.	12 5 0
„	12×10	.	.	.	.	.	.	.	14 10 0
„	15×12	.	.	.	.	.	.	.	18 5 6

A CHOICE OF LENSES FOR THE ABOVE.

	The Soho.	Voigtländer's M. R. Euryscope.	M. & Co's. wide angle.	Voigtländer's Anastigmatic wide angle series V.
For plates $6\frac{1}{2} \times 4\frac{3}{4}$	63/	92/	60/	64/
„ $8\frac{1}{2} \times 6\frac{1}{2}$	78/	123/	80/	80/
„ 10×8	102/	145/	100/	100/
„ 12×10	140/	176/	140/	120/
„ 15×12	200/	264/	200/	180/

MARION & CO., 22 & 23 Soho Square, London, W.

MARION'S "PERFECTION" CAMERA—*Continued.*

The Soho is an excellent Lens for General Landscape work, and will also serve for taking groups.

The Voigtländer's Medium Rapid Euryscope takes the first rank as a Landscape Lens, and nothing better can be bought.

M. & Co.'s Wide Angle: this is a Lens to be used for Street Views, and taking buildings in confined situations; the Rectilinear Lenses are not suitable for this class of work, and to be enabled to get all classes of out-door scenes—both the Rectilinear and the Wide Angle should be purchased.

Voigtländer's Anastigmatic Wide Angle is of the same character as the M. & Co.'s Wide Angle, but it gives a greater Angle and a finer definition: besides being used for Street views, it is one of the best copying Lenses made.

MARION'S "EMPIRE" CAMERAS

Will stand any climate—either extreme heat or cold, made only of well-seasoned best Spanish mahogany, and solidly constructed, with the best workmanship and with all the latest improvements. Prices, including 3 Double Backs:

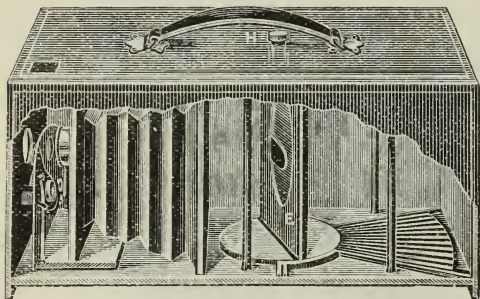
FOR PLATES

	$6\frac{1}{2} \times 4\frac{3}{4}$ No. 528	$8\frac{1}{2} \times 6\frac{1}{2}$ No. 529	10 × 8 No. 530	12 × 10 No. 531	15 × 12 No. 532
Cameras with 3 Double Backs	215/	260/	320/	370/	550/
Voigtländer's new Medium Rapid Euryscope.	92/	123/	145/	176/	264/
No. 903. Best solid leather cases . . .	29/	32/	40/	50/	60/
„ 701. Ashford's patent Tripod Stand .	18/6	21/	25/	32/	42/
„ 703. Table Stand with 3 tripod legs . .	...	...	...	50/	50/
„ 803. Cadett's patent Lightning Shutter	30/	35/	40/	40/	45
	<u>384/6</u>	<u>471/</u>	<u>570/</u>	<u>718/</u>	<u>1011/</u>
Extra price for brass binding.	41/6	41/6	51/	51/	51/

MARION & CO., 22 & 23 Soho Square, London, W.

MARION'S NEW HAND CAMERA. THE RADIAL.

(DICKINSON'S PATENT)



The RADIAL CAMERA takes its name from the novel method of carrying the plates in radiating grooves, which find their common axis in the centre of the exposing position.

The exposing groove runs across the axis of a drum. The drum is made to revolve in such manner that this groove can, with great exactness, be brought to, and made

to form a continuation of, *any one* of the radiating grooves wherein the plates are stored. When the plate is transferred from the one half of this now combined groove into the other half, the drum is again turned to a defined position, and the plate is then in its exposing position. It will be seen that to transfer the plate into its original groove and to obtain another, it will only be necessary to repeat the action already taken until all the 12 plates have been exposed. Size of plates as below. The Camera is supplied either polished or covered in morocco, and the shape is such that it can be very conveniently carried. We specially invite inspection. The working parts of the Camera are made of metal, and will stand any climate.

PRICES.

ONE QUALITY OF WORK ONLY—THE BEST.

- | | |
|--|--------------------|
| 1. The Radial Camera, of best workmanship as described, complete in every way, with shutter, etc., outside finish, polished mahogany, and leather handles, <i>but without lens</i> , including fitting customers' own suitable lens | £5 10 0 |
| 2. The Radial Camera, of best workmanship as described, complete in every way, with shutter, etc., outside covered in good style with best black morocco leather, <i>but without lens</i> , including fitting customers' own suitable lens | 6 6 0 |
| | No. 1. No. 2. |
| If fitted with a cheap but still very good rectilinear lens that covers well to edges | £7 0 0 £7 15 0 |
| If fitted with Marion's now well-known and highly-approved "Soho" $\frac{1}{4}$ -plate lens, guaranteed | 7 15 0 8 10 0 |
| If fitted with Voigtländer's new specially made "Hand Camera Lens" of best possible construction | 10 0 0 10 15 0 |
| Price of Camera $3\frac{1}{4} \times 3\frac{1}{4}$, fitted with a good Rectilinear Lens, Polished Mahogany | 5 15 0 |
| If covered with Morocco Leather | 6 6 0 |
| Price of Camera $6\frac{1}{2} \times 4\frac{3}{4}$, fitted with a good Rectilinear Lens, Polished Mahogany | 12 0 0 |
| If above is covered with Morocco Leather | 13 0 0 |

MARION & CO., 22 & 23 Soho Square, London, W.

MARION'S HAND CAMERA.

Marvellous! "Puck." Marvellous!

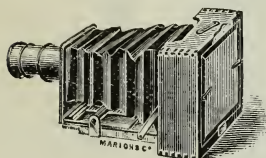
THE "PUCK" PHOTOGRAPHIC APPARATUS.

A MARVEL OF CHEAPNESS.

- The "Puck" Camera and Lens complete, with 1 plate ready for exposure 1/8
 The "Puck" Developing Set 1/8
 The "Puck" Printing Set 1/8
 The Complete Set of "Puck" Apparatus, including extra plates, in nice partitioned box 7/4



This is not a toy but a thoroughly practical apparatus, giving very good photographs, size about $2\frac{1}{2}$ in. square.



Miniature Landscape Camera & Lens.

Reduced Price.

For Plates $3\frac{1}{4} \times 2\frac{3}{8}$ —£1 : 1s

KRUEGENER'S BOOK CAMERA.

Reduced Price, for 24 Plates $1\frac{5}{8}$ in. square,

£2 : 5s.

Ditto, ditto, for 30 Lantern Plates, £7 : 10s.

THE BAEDICKER CAMERA

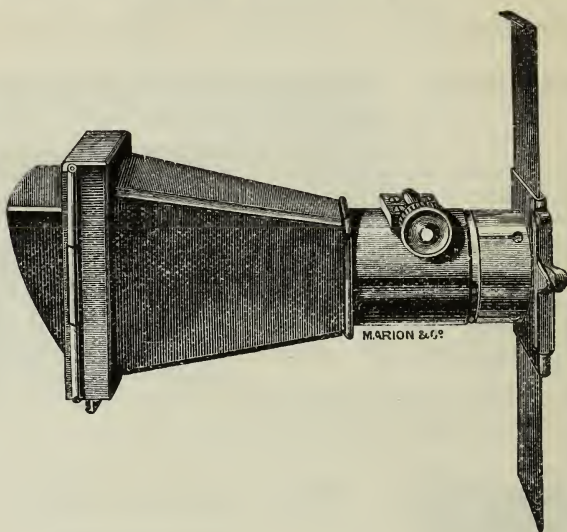
takes 24 plates. $6 \times 4\frac{1}{2}$ cm.

Price £3 : 10s.



MARION & CO., 22 & 23 Soho Square, London, W.

MARION'S METAL MINIATURE HAND CAMERA.



This illustration represents the Metal Miniature Camera in about half size of No. 2 ; it will be seen that the Camera and 12 slides may easily be carried in the pocket. These Cameras meet a long-felt want. They have an instantaneous drop shutter, and being fitted with excellent lenses, give most effective and sharp little pictures. The sighting is done through the hole in the shutter. Focussing is easily effected. Made in 5 sizes, prices of which are given below, they are all very similar in pattern.

FOR PLATES

	$1\frac{1}{4} \times 1\frac{1}{4}$	2×2	$3\frac{1}{4} \times 3\frac{1}{4}$	$4\frac{1}{4} \times 3\frac{1}{4}$	$6\frac{1}{2} \times 4\frac{3}{4}$
Camera, Lens, Shutter, Focussing Screen, and one Back	25/	45/	84/	105/	126/
Single Backs for same each	1/	2/	$\frac{3}{4}$	5/	8/
Marion's Instantaneous Dry Plates . . per doz.	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{3}{8}$
Polished Walnut Case, with partitions for Camera, 12 Slides, etc. ; also serves as a Camera Stand, very neat	7/6	10/6	18/	24/	30/
Kershaw's Patent Pneumatic Shutter, if desired to replace extra	18/	18/	18/	21/	21/
COMPLETE SET, including Camera, Lens, and 12 Slides, in Polished Walnut Case ; 6 dozen Plates, Trays, Chemicals, etc., necessary for development, and a supply of Printing Material and Apparatus. The whole complete, in Polished Mahogany Box	80/	110/	210/	238/	340/

MARION & CO., 22 & 23 Soho Square, London, W.

MARION'S
 "PARCEL" DETECTIVE CAMERA (Patent).
 NEW MAKE. MUCH IMPROVED.
 FOR PLATES $4\frac{1}{4} \times 3\frac{1}{4}$.



THIS Camera is made box-shape, is neatly covered with brown linen-lined paper, and tied with string like an ordinary parcel, of which it has the exact appearance. The object is to disguise its real use, and to permit a Photograph to be taken without raising the slightest suspicion. After slipping the plates in from the holder, which may be done in daylight, it is only necessary to adjust the focus and to touch a spring to obtain a sharp Negative; the Plate is then returned to its holder. These Plate-holders are made of india-rubber, impervious to light and atmosphere, and being flexible, thin, and light, will pack in a very small compass. The Camera is fitted with a good double combination quick-acting Lens. It can easily be opened, when desirable, to clean from dust, etc.

Many of the beautiful pictures taken by Mr. T. C. Hepworth were done with this Camera. We can highly recommend it.

PARCEL CAMERA complete, with one Plate-Holder	.	.	£4	0	0
Extra India-Rubber Plate-Holders	.	per doz.	1	0	0
Above Camera covered in Leather instead of Paper, with Leather Straps and Handle	.	.	4	14	0
Marion's Instantaneous Plates, suitable for this Camera.	.	per doz.	0	1	6

MARION & CO., 22 & 23 Soho Square, London, W.

VOIGTLÄNDER & SON'S CELEBRATED EURYSCOPE LENSES

(None are genuine unless Voigtländer's name is on the brass tube.)

The series known as **MEDIUM RAPID EURYSCOPE** stand in the first rank for Landscape work, we have never known them fail to give satisfaction to purchasers.

No.	Aperture.	Equivalent Focus.	Size of Plates.	Price.
0a	1 inch	6 inches	5 × 4	£3 15 0
00a	1 $\frac{1}{4}$ "	8 $\frac{1}{4}$ "	7 $\frac{1}{2}$ × 5	4 12 0
1a	1 $\frac{1}{2}$ "	10 $\frac{3}{4}$ "	8 $\frac{1}{2}$ × 6 $\frac{1}{2}$	6 3 0
2a	1 $\frac{3}{4}$ "	13 "	10 × 8	7 5 0
3a	2 inches	16 "	12 × 10	8 16 0
4a	2 $\frac{1}{2}$ "	20 "	15 × 12	13 4 0
5a	3 "	24 "	18 × 16	19 7 0
6a	3 $\frac{1}{2}$ "	28 "	22 × 18	25 6 0
7a	4 "	32 "	25 × 22	31 18 0

The **RAPID EURYSCOPE** is particularly successful in group work, it is also largely used for portraiture, and near landscape work.

No.	Aperture.	Equivalent Focus.	Size of Landscape.	Size of Group.	Price.
0	1 inch	4 $\frac{3}{4}$ inches	4 $\frac{1}{2}$ × 3	4 × 3	£3 6 0
00	1 $\frac{1}{4}$ "	6 $\frac{1}{2}$ "	5 $\frac{1}{2}$ × 4 $\frac{1}{2}$	4 $\frac{1}{2}$ × 3 $\frac{1}{2}$	4 8 0
1	1 $\frac{1}{2}$ "	8 $\frac{1}{6}$ "	6 × 5	5 $\frac{1}{2}$ × 4 $\frac{1}{2}$	5 10 0
2	1 $\frac{3}{4}$ "	9 $\frac{1}{2}$ "	7 × 6	6 × 5	6 7 0
3	2 inches	11 "	8 $\frac{1}{2}$ × 6 $\frac{1}{2}$	7 × 6	7 14 0
4	2 $\frac{1}{2}$ "	14 "	10 $\frac{1}{2}$ × 8 $\frac{1}{2}$	8 $\frac{1}{2}$ × 6 $\frac{1}{2}$	11 0 0
5	3 "	16 $\frac{2}{3}$ "	13 × 10 $\frac{1}{2}$	10 $\frac{1}{2}$ × 8 $\frac{1}{2}$	16 10 0
6	3 $\frac{1}{2}$ "	20 $\frac{1}{4}$ "	16 × 13	13 × 11	22 0 0
7	4 "	23 $\frac{1}{4}$ "	20 × 17	16 × 13	28 12 0
8	5 "	30 $\frac{1}{2}$ "	25 × 22	22 × 18	52 5 0

For street views or architecture use the **THE WIDE ANGLE EURYSCOPE**.

No.	Aperture.	Equivalent Focus.	Large Stop.	Small Stop.	Price.
1	1 $\frac{5}{8}$ inch	3 $\frac{1}{4}$ inches	4 × 3	5 × 4	£3 13 0
2	1 $\frac{3}{4}$ "	4 $\frac{6}{7}$ "	5 × 4	7 $\frac{1}{2}$ × 5	3 19 0
3	1 $\frac{1}{2}$ "	5 $\frac{3}{4}$ "	6 × 4 $\frac{1}{2}$	8 × 6	4 8 0
4	1 $\frac{1}{2}$ "	6 $\frac{1}{3}$ "	7 $\frac{1}{2}$ × 5 $\frac{1}{2}$	9 × 7	4 19 0
5	1 $\frac{1}{2}$ "	7 $\frac{3}{4}$ "	8 $\frac{1}{2}$ × 6 $\frac{1}{2}$	10 × 8	6 7 0
6	1 "	9 "	9 $\frac{1}{2}$ × 7 $\frac{1}{2}$	12 × 10	8 7 0
7	1 $\frac{1}{4}$ "	15 "	13 × 11	16 × 14	11 0 0
8	1 $\frac{1}{2}$ "	20 "	17 × 15	20 × 18	15 8 0
9	1 $\frac{1}{4}$ "	25 "	21 × 19	24 × 22	20 9 0
10	2 inches	32 "	23 × 21	26 × 23	33 9 0

MARION & CO., 22 & 23 Soho Square, London, W.

VOIGTLÄNDER'S ANASTIGMATIC LENSES.

The special feature of these lenses is their power of giving sharp definition at the margins in the highest degree. This, together with their great width of angle, gives them enormous advantages over all other Wide-Angle Lenses. Their uses are the same as those of the Wide-Angle Euryscopes. In point of *Rapidity* Series III. is between that of the *Rapid Wide-Angle* Euryscope and the ordinary Wide-Angle Euryscope. Series IV. and V. are much slower, but more suitable for Architectural Work, Copying, etc.

SERIES III.

FULL APERTURE f. 7. ANGLE OF VIEW 80°.

No.	Aperture.	Focal Length.	Size of Plate.	Price with Ordinary Diaphragms.	Price with Iris Diaphragms.
1	$\frac{5}{8}$ inch	3 $\frac{1}{8}$ inches	4 × 3 $\frac{1}{4}$ inches	£3 10 0	£4 5 0
2	$\frac{1}{2}$ " "	4 $\frac{3}{8}$ " "	5 × 4 " "	4 0 0	4 15 0
3	I " "	5 $\frac{7}{8}$ " "	5 $\frac{3}{4}$ × 4 $\frac{3}{4}$ " "	4 10 0	5 5 0
4	I $\frac{1}{4}$ " "	7 $\frac{1}{8}$ " "	6 $\frac{1}{2}$ × 4 $\frac{3}{4}$ " "	6 0 0	6 15 0
5	I $\frac{1}{8}$ " "	8 $\frac{1}{8}$ " "	8 $\frac{1}{4}$ × 5 $\frac{1}{4}$ " "	7 10 0	8 5 0
6	I $\frac{1}{16}$ " "	9 $\frac{7}{8}$ " "	8 $\frac{1}{2}$ × 6 $\frac{1}{2}$ " "	9 0 0	9 15 0
7	2 $\frac{1}{16}$ inches	12 $\frac{1}{8}$ " "	10 × 8 " "	12 0 0	13 0 0
8	2 $\frac{1}{8}$ " "	17 $\frac{7}{8}$ " "	12 × 10 " "	19 0 0	20 0 0
9	3 $\frac{1}{4}$ " "	23 $\frac{1}{8}$ " "	15 × 12 " "	27 0 0	...

SERIES IV.

FULL APERTURE f. 12.5. ANGLE OF VIEW 100°.

No.	Aperture.	Focal Length.	Size of Plate.	Price with Ordinary Diaphragms.	Price with Iris Diaphragms.
1	$\frac{1}{4}$ inch	2 $\frac{1}{2}$ inches	4 X 3 $\frac{1}{4}$ inches	£3 4 0	..
2	"	3 $\frac{1}{2}$ "	5 X 4 "	3 4 0	..
3	"	4 $\frac{1}{2}$ "	5 $\frac{3}{4}$ X 4 $\frac{3}{4}$ "	3 4 0	..
4	"	6 "	8 $\frac{1}{4}$ X 5 $\frac{1}{4}$ "	4 0 0	..
5	"	7 $\frac{1}{2}$ "	10 X 8 "	5 0 0	£5 15 0
6	"	10 $\frac{1}{2}$ "	12 X 10 "	7 10 0	8 5 0
7	1 $\frac{1}{8}$ "	15 $\frac{1}{2}$ "	15 X 12 "	10 0 0	10 15 0
8	2 inches	23 $\frac{1}{2}$ "	18 X 16 "	17 10 0	18 10 0
9	3 "	35 $\frac{3}{8}$ "	22 X 20 "	40 0 0	..
10	3 $\frac{1}{8}$ "	48 $\frac{5}{8}$ "	29 X 24 "	90 0 0	..

No. 1 to No. 5 are provided with Rotating Stops, No. 6 to No. 10 with Sliding Diaphragms. No. 5 to No. 8 can be furnished on special demand with Iris Diaphragms.

SERIES V.

FULL APERTURE f. 18. ANGLE OF VIEW 110°.

No.	Aperture.	Focal Length.	Size of Plate.	Price.
1	$\frac{1}{8}$ inch	31 $\frac{1}{8}$ inches	5 $\frac{1}{2}$ X 4 $\frac{3}{4}$ inches	£3 4 0
2	1 $\frac{1}{8}$ "	41 $\frac{1}{8}$ "	6 $\frac{1}{2}$ X 4 $\frac{3}{4}$ "	3 4 0
3	"	5 $\frac{1}{8}$ "	8 $\frac{1}{2}$ X 6 $\frac{1}{2}$ "	4 0 0
4	"	7 $\frac{1}{8}$ "	10 X 8 "	5 0 0
5	"	8 $\frac{1}{8}$ "	12 X 10 "	6 0 0
6	"	10 $\frac{1}{8}$ "	13 $\frac{1}{4}$ X 10 $\frac{1}{4}$ "	7 10 0
7	"	12 $\frac{1}{8}$ "	15 X 12 "	9 0 0
8	"	18 $\frac{1}{8}$ "	15 X 12 "	12 0 0
9	1 $\frac{1}{8}$ "	24 $\frac{1}{8}$ "	18 X 16 "	17 10 0
10	2 $\frac{1}{8}$ inches	37 $\frac{1}{8}$ "	25 X 20 "	35 0 0
11	3 "	51 $\frac{1}{8}$ "	34 X 27 $\frac{1}{2}$ "	60 0 0
12	4 "	65 "	40 X 35 "	100 0 0

No. 1 to No. 6 are provided with Rotating Stops, No. 7 to No. 12 with ordinary Sliding Stops. A matched pair of identical foci for stereos will be charged 4s. more for each lens.

MARION'S PHOTOGRAPHIC MOUNTS.

FACTORY, COURBEVOIE, NEAR PARIS.

Marion's Silver Gray new tint, expressly manufactured for Silver, Platinotype, and Bromide Prints, and is unsurpassed for giving value to the photographic tones. Very fine quality for painting on.

No.	Size.	Best.			B.M.			Best.			B.M.		
		100	1000	10000	100	1000	10000	100	1000	10000	100	1000	10000
2000	Carte Midget	2 $\frac{5}{16}$	$\times$ 1 $\frac{5}{16}$	Blind Bevel	1/9	14/0	1/6	12/0	Gold Bevels	2/6	21/4	2/3	19/4
2001	Promenade Midget	3 $\frac{1}{8}$	$\times$ 1 $\frac{9}{16}$	"	2/0	16/0	1/8	13/4	"	2/10	23/4	2/6	20/8
2002	C.D.V.	4 $\frac{1}{16}$	$\times$ 2 $\frac{3}{8}$	"	2/9	24/4	2/2	18/8	"	3/7	33/0	3/0	27/4
2003	Cabinet	6 $\frac{3}{8}$	$\times$ 4 $\frac{1}{8}$	"	5/6	52/0	4/0	38/8	"	7/0	66/0	5/6	52/8
2004	For $\frac{1}{4}$ -plate views	4 $\frac{1}{4}$	$\times$ 3 $\frac{1}{4}$	"	4/4	41/4	3/3	29/4	"	5/4	52/0	4/3	40/0
2004A	For 5 $\times$ 4 views	5	$\times$ 4	"	5/6	52/8	4/4	41/0	"	7/4	66/8	6/0	55/0
2005	For $\frac{1}{2}$ -plate views	6 $\frac{1}{2}$	$\times$ 4 $\frac{3}{4}$	"	7/6	68/0	5/3	48/0	"	9/6	88/0	7/9	74/8
2006	For 1 $\times$ 1 plate views	8 $\frac{1}{2}$	$\times$ 6 $\frac{1}{2}$	"	15/6	150/0	12/6	120/0	"	20/0	190/0	17/0	160/0
2007	Boudoir	8 $\frac{1}{4}$	$\times$ 5	"	12/6	117/4	9/6	90/8	"	16/0	150/8	13/0	124/0
2008	Imperial	10	$\times$ 6 $\frac{3}{4}$	"	17/9	173/4	14/0	133/4	"	21/9	213/4	18/0	173/4
2009	Panel	13	$\times$ 7 $\frac{1}{2}$	"	33/0	320/0	25/0	240/0	"	36/6	357/4	28/6	277/4

Marion's Silver Gray with India Paper laid on, and Plate Mark Impress, Edges Real Gold Bevels.

		per doz.		per 100	
2010	For $\frac{1}{4}$ -plate photos with suitable margin	.	.	.	13/4
2011	For $\frac{1}{2}$ -plate photos	"	"	.	21/4
2012	For 1 $\times$ 1 photos	"	"	.	34/0
2013	For 10 $\times$ 8 photos	"	"	.	64/0
2014	For 12 $\times$ 10 photos	"	"	.	90/8
2015	For Panel photos	"	"	.	90/8

REAL GOLD BEVELLED EDGE MOUNTS,

FOR PORTRAITS OR VIEWS, AND FOR PAINTING ON. STOCK SIZES AND TINTS, &c. &c.
Manufactured by Marion & Co., Courbevoite, near Paris.

SIZES.	No.	THICKNESS.	TINTS.	BEST QUALITY.		SECOND QUALITY.	
				Per 100.	Per doz.	Per 100.	Per doz.
Carte Midget	2 1/8 x 1 1/8	..	Black and Olive	3/	..	2/9	..
Promenade Midget	3 1/8 x 1 1/8	8-Sheet	" " " " and Olive.	3/4	..	..	..
	3 x 1 1/4	8	" " " " " "	4/	..	..	..
	4 1/4 x 3	8	" " " " " "	5/5	1/	..	..
C.D.V.	4 1/8 x 2 3/8	8	Cream, Rose, Pale " Blue,	4/	9/	3/4	8/
	4 1/8 x 2 3/8	12	Chocolate, Olive, Black, {	4/8	1/	..	..
			Fawn, and Slate-Gray				
	5 x 2 1/4	8	Cream, Rose, and Olive.	5/2	1/	..	..
1/4-Plate Views	4 1/4 x 3 1/4	8	Olive	5/4	1/	..	..
	5 1/2 x 3 1/4	8	Cream, Rose, and Olive.	8/4	1/4	..	..
5 x 4	5 x 4	8	Olive	7/4	1/3	..	..
	6 1/4 x 4	8	Cream, Rose, and Olive.	9/1	1/5	..	..
1/2-Plate	6 1/2 x 4 1/4	8	Olive	9/6	1/6	..	..
Malvern	6 1/2 x 3 1/4	12	Cream, Olive, Black, and {	10/4	1/7	..	..
			Chocolate				
Cabinet	6 5/8 x 4 1/8	8	Cream, Rose, Pale Blue, {	7/2	1/4	6/	1/
"	6 5/8 x 4 1/8	12	Chocolate, Olive, Black, {	9/4	1/9	..	..
			Fawn, and Slate-Gray				
Promenade	8 1/4 x 3 3/8	12	Cream, Black, Olive, and {	12/10	2/	10/	1/6
			Chocolate				
Boudoir	8 1/4 x 5	12	" " " " " "	16/	2/4	13/4	2/6
Imperial	10 x 6 1/2	12	Cream and Olive	22/8	3/4	17/	2/6
	8 1/2 x 6 1/2	12	" " " " " "	17/	2/5	..	..
	10 x 8	12	" " " " " "	19/4	2/10	16/	2/4
Panel	11 1/2 x 7 1/2	12	" " " " " "	30/8	4/2	20/8	2/10
	13 x 7 1/2	15	Cream, Black, and Olive	36/	4/10	25/4	3/6
"	13 x 9 1/2	20	" " " " " "	42/	6/4	28/	4/
	14 x 11	15	" " " " " "	56/	8/	29/	4/2
Large Panel	17 x 10 1/2	19	Cream and Olive	42/8	6/4	..	..
	17 x 10 1/2	30	" " " " " "	74/8	10/	..	..
Grand "Panel	23 x 13 1/4	40	Olive and Black	..	13/8	..	..
			" " " " " "	..	18/8	..	..
			Black	..	50/8	..	..

MARION & CO., 22 & 23 Soho Square, London, W.

LARGE MOUNTS.

(Manufactured by MARION & Co., Courbevoie, near Paris.)

Every care is taken in the Manufacture, and the Quality will be found unsurpassed for Purity of Material and Fineness of Surface.

SECOND QUALITY PLAIN CREAM TONED. WITH RED LINES.

Kept in Stock.

No.	Thickness.	Size—Inches.	Per doz.	Per gross.
1000	5-Sheet	8 × 6	17	48
1001	5 "	9½ × 7½	19½	71
1002	8 "	12½ × 9½	15	139
1003	8 "	13½ × 10½	19	178
1004	8 "	16 × 13	28	28
1005	8 "	19 × 14	34	33
1006	10 "	22 × 17	49	52
1007	10 "	25 × 19	59	61
1008	10 "	26 × 21	71	80

SECOND QUALITY PLAIN CREAM TONED. WITH RED LINES.

Kept in Stock.

No.	Thickness.	Size—Inches.	Size of Line.	Per doz.	Per gross.
1009	5-Sheet	8 × 6	5½ × 4½	10	74
1010	5 "	9½ × 7½	6½ × 4½	1	10
1011	8 "	12½ × 9½	8½ × 6½	18	168
1012	8 "	13½ × 10½	8½ × 6½	2	214
1013	8 "	16 × 13	10½ × 8½	3	32
1014	8 "	19 × 14	12½ × 10½	37	368
1015	10 "	22 × 17	15½ × 12½	54	588
1016	10 "	25 × 19			
1017	10 "	26 × 21			

BEST WHITE OR CREAM-TONED CARDBOARD FOR MOUNTING PHOTOGRAPHS.

Kept in Stock.

No.	Thickness.	Size—Inches.	Per doz.	Per gross.
1018	5-Sheet	8 × 6	18	63
1019	5 "	9½ × 7½	11	89
1020	8 "	12½ × 9½	17	172
1021	8 "	13½ × 10½	21	214
1022	8 "	16 × 13	39	3810
1023	8 "	19 × 14	47	432
1024	10 "	19 × 14	48	5010
1025	10 "	22 × 17	67	6714
1026	10 "	25 × 19	74	8018
1027	10 "	26 × 21	811	10018
1028	3 "	(for enamelling) 24½ × 18½	44	44
1029	10 "	(Cream only) 37 × 24	32	320

INDIA TINTED BEST WHITE CARDBOARD.

Kept in Stock.

No.	Thickness.	Size—Inches.	Size of Tint.	Per doz.	Per gross.
1030	5-Sheet	8 × 6	5½ × 3½	17	154
1031	5 "	9½ × 7½	6½ × 5½	19	185
1032	8 "	12½ × 9½	8½ × 6½	28	271
1033	8 "	13½ × 10½	9½ × 7½	32	324
1034	8 "	16 × 13	11 × 9	48	508
1035	8 "	19 × 14	12 × 10	410	55
1036	10 "	19 × 14	12 × 10	6	648
1037	10 "	22 × 17	14 × 12	74	8010
1038	10 "	25 × 19	16 × 14	9	1014
1039	10 "	26 × 21	18 × 15	112	12410

MARION'S READY SENSITISED PAPERS.

No. 1000. Best Rives Thick, 10 kilo, per quire
13/6, $\frac{1}{2}$ quire 7/3, $\frac{1}{4}$ quire 3/9.

Ready Cut in the following sizes :

C.D.V. size . . .	42 Pieces . . .	per packet	1/
$\frac{1}{4}$ -Plate . . .	25 „ . . .	„	1/
Cabinet . . .	15 „ . . .	„	1/
$\frac{1}{2}$ „ . . .	10 „ . . .	„	1/
$\frac{1}{1}$ „ . . .	12 „ . . .	„	1/7
10 $\times$ 8 . . .	12 „ . . .	„	2/4
11 $\frac{1}{2}$ $\times$ 9 $\frac{1}{2}$. . .	12 „ . . .	„	3/

No. 1002. Brilliant Double Albumen, 10 kilo,
per quire 15/, $\frac{1}{2}$ quire 8/, $\frac{1}{4}$ quire 4/3.

$\frac{1}{4}$ Plate . . .	25 Pieces . . .	per packet	1/3
$\frac{1}{2}$ „ . . .	10 „ . . .	„	1/5
$\frac{1}{1}$ „ . . .	12 „ . . .	„	2/
10 $\times$ 8 . . .	12 „ . . .	„	2/4
11 $\frac{1}{2}$ $\times$ 9 $\frac{1}{2}$. . .	12 „ . . .	„	3/10

MARION & CO.'S BROMIDE PAPER.

The paper is made, Smooth (A), and Rough (B). When ordering please state which is required, also if White or Rose.

In Packets of 12 Sheets.

4 $\frac{1}{4}$ $\times$ 3 $\frac{1}{4}$. . .	per packet	/8
6 $\frac{1}{2}$ $\times$ 4 $\frac{3}{4}$. . .	„	1/6
8 $\frac{1}{2}$ $\times$ 6 $\frac{1}{2}$. . .	„	2/6
10 $\times$ 8 . . .	„	3/6
12 $\frac{1}{2}$ $\times$ 10 $\frac{1}{2}$. . .	„	5/6
15 $\frac{1}{2}$ $\times$ 12 $\frac{1}{2}$. . .	„	7/6

This paper is more rapid than most other makes ; it also yields a more brilliant print. The Rose tinted, which we have recently introduced, is very much liked.

MARION & CO., 22 & 23 Soho Square, London, W.

TALBOT'S "BETA" CHLORIDE PAPER.

This ready sensitised paper must be kept absolutely dry. It is best to place it in a wooden case or in a cardboard tube. It will keep its good qualities for several months.

Printing is the same as on albumen Paper.

PRICE.

Size :	$4\frac{1}{4} \times 3\frac{1}{4}$	$6\frac{1}{2} \times 4\frac{3}{4}$	$8\frac{1}{2} \times 6\frac{1}{2}$	10×8	12×10	15×12
25 Sheets.	1/6	2/8	6/6	8/0	11/6	17/0
	Size : 24×20					
	3 Sheets 6/0					

Toning-fixing Bath . . . per bottle 3/.

Enamelling Plates . . . 14×10 . . . each 1/6.

MARION'S FERRO-PRUSSATE PAPER.

IN CUT SIZES.

After exposure to light, simply wash in cold water and the print is finished ! The Paper should be kept dry ; it should be protected from white light, but will not hurt by exposure to gas or yellow light. Very serviceable for taking proofs, also for reproducing Lace, Flowers, and Leaves, and Prints from ordinary photographic Negatives are very charming.

SOLD IN PACKETS OF 25 PIECES EACH.

$4\frac{1}{4} \times 3\frac{1}{4}$	.	.	.	.	.	.	1/8
$6\frac{1}{2} \times 4\frac{3}{4}$	.	.	.	.	.	.	1/3
$8\frac{1}{2} \times 6\frac{1}{2}$	.	.	.	.	.	.	2/6
10×8	.	.	.	.	.	.	3/6

MARION & CO., 22 & 23 Soho Square, London, W.

MARION'S FERRO-PRUSSATE, OR BLUE PROCESS.

Used in the Drawing Departments of the leading Shipbuilders, Railways, Engineers, Contractors, Architects, and others.

By this process, Drawings, Patterns, Plans, etc., may be reproduced very quickly by simply using the Prepared Paper, Light, and Water.

Of all the various methods for reproducing Drawing, *Marion's Ferro-Prussiate Process* is still the simplest and most practicable. No complicated apparatus is necessary. No dangerous acids or poisonous substances are used. The Print simply requires washing in cold water.

Sample Sheets (and Print) Post Free, 1s. 8d.

No. 494. A good quality paper, for printing from transparent Drawings or Negatives.

No. 515. Same as above, but a stronger and thicker paper. For workshop use.

No. 507. A very thin paper, for making negative prints to print from, the result to be blue lines on white ground; or for Foreign Postage.

No. 524. A good strong paper for workshop use; **VERY CHEAP.** Quality equal to 515, but of same thickness as 494.

No. 516. A strong useful cloth, that saves any after trouble in mounting.

494 Paper.			515 Paper.		
494/65	25 in. wide	7/	515/65	25 in. wide	5/
494/75	30 „	8/	515/75	30 „	5/9
494/100	39 „	11/	515/100	39 „	7/
507 Paper.					
507/65	25 in. wide	7/			
507/75	30 „	8/			
507/100	39 „	11/			

(All excepting No. 516 supplied in Rolls 32 feet long.)

524/75, 30 in. wide, 3s. 9d. 524/100, 39 in. wide, 5s.

516 Ferro-Prussiate Tracing Cloth, 16 ft. long x 30 in. wide, 10s. 6d.

The paper being very sensitive to light, must be kept in the dark.

This is imperative.

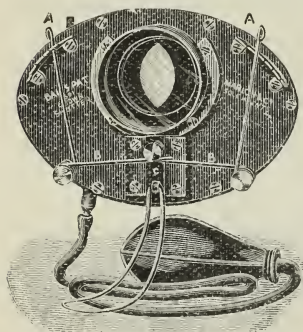
MARION & CO., 22 & 23 Soho Square, London, W.

THE PLATINOTYPE PROCESS, FOR PERMANENT PRINTING.

The following Paper is mostly used.

Quality **A** for the Hot Bath Process.

						Postage one tube.
24 pieces in tube, size	$4\frac{1}{4} \times 3\frac{1}{4}$	.	.	.	1/6	3d.
" "	5×4	.	.	.	2/3	3d.
" "	$6\frac{1}{2} \times 4\frac{3}{4}$	.	.	.	3/6	3d.
" "	$7\frac{1}{2} \times 5$	.	.	.	4/6	3d.
" "	$8\frac{1}{2} \times 6\frac{1}{2}$	.	.	.	6/	3d.
" "	10×8	.	.	.	8/6	3d.
12 pieces in tube, size	12×10	.	.	.	6/6	3d.
" "	15×12	.	.	.	9/6	3d.
3 sheets in tube, of	26×20	.	.	.	6/6	5d.
6	" "	.	.	.	12/6	5d.
12	" "	.	.	.	24/0	6d.
24	" "	.	.	.	48/0	8d.



BAIN'S CROWN SHUTTER.

The Quickest Shutter on the market, and yet can be used for the slowest time exposures.

Price, with tubes for taking the Lenses,

$\frac{1}{4}$ and $\frac{1}{2}$ -plate, 30/; $\frac{1}{1}$ -plate, 35/;
10 x 8 and 12 x 10, 40/.

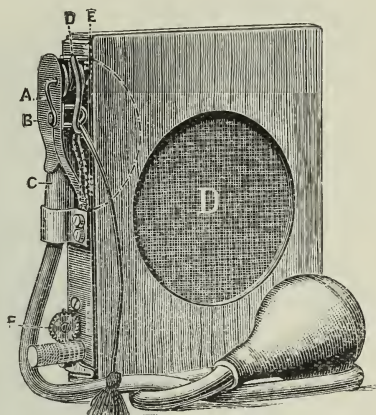
MARION & CO., 22 & 23 Soho Square, London, W.

KERSHAW'S NEW SHUTTER (Patent).

MARION & CO., Wholesale Agents.

For Time as well as Instantaneous Exposures.

The original Shutter of Kershaw is well known as being one of the very best *Instantaneous* Shutters in the market—the only thing wanted to make it a perfect Shutter was an arrangement for giving *time* exposures. This has now been achieved, and we can safely recommend this New Shutter as one of the best all-round Shutters. For time exposures, see that the wire pin E is turned up, also that the little cog-wheel F should have the broad arrow opposite the word speed on the brass plate. The string may now be pulled quite out until the blind has the letter U in centre, fix it so by the brass wire catch, the end of which drops into a hole in the pulley wheel. It is



now ready for exposure, which is operated by squeezing the ball, and as long as the ball is compressed so long is the blind open; by ceasing the pressure the blind closes. For instantaneous exposures the wire pin E is turned downwards, and the other operations are performed as described for time exposures. The speed is increased by turning the spindle round to the right several times, and decreased by pressing the ratchet underneath, when the spindle revolves rapidly and lessens the tension. A great point about this Shutter is its noiselessness when in operation, thus it is best adapted for photographing children or animals.

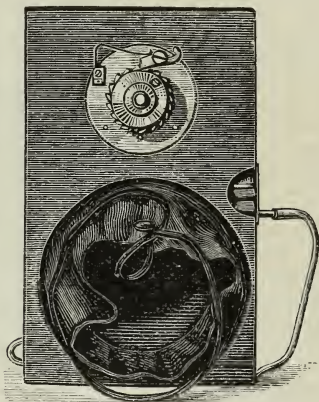
PRICE OF THE NEW SHUTTER with Cadett's Patent Pneumatic Release.

For Hood of Lens,	$1\frac{1}{2}$ in. and under	.	.	.	.	17/
"	"	$1\frac{3}{4}$ "	"	.	.	18/
"	"	2 "	"	.	.	19/
"	"	$2\frac{1}{4}$ "	"	.	.	20/
"	"	$2\frac{1}{2}$ "	"	.	.	22/
"	"	$2\frac{3}{4}$ "	"	.	.	24/6
"	"	3 "	"	.	.	27/
"	"	$3\frac{1}{2}$ "	"	.	.	31/
"	"	4 "	"	.	.	37/
"	"	$4\frac{1}{2}$ "	"	.	.	41/
"	"	5 "	"	.	.	47/

MARION & CO., 22 & 23 Soho Square, London, W.

CADETT'S LIGHTNING EBONITE SHUTTER.

With Cadett's Patent Pneumatic Arrangement.



This invention of Mr. Cadett is a most ingenious arrangement, providing all exposures from indefinite duration to a very rapid one. The Shutter obtained the Silver Medal (highest award) at the International Inventions Exhibition. We recommend this as the "Mulum in Parvo" of shutters, and also as a beautiful and ingenious piece of work. The exposures are quite under control, and are given without vibration. There is also an arrangement for focussing.

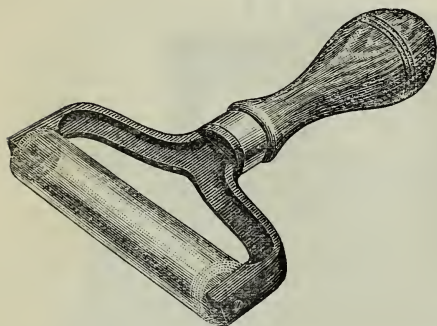
No. 1.	Suitable for lens of	$1\frac{7}{8}$	diameter or under	.	.	.	30/
No. 2.	"	$2\frac{3}{8}$	"	"	.	.	35/
No. 3.	"	$3\frac{1}{4}$	"	"	.	.	40/
No. 4.	"	$3\frac{1}{2}$	"	"	.	.	45/

From G. M. BAINES, Esq., Quinta Nova, Carcavellas, Correios d'Ouras, Portugal.—
"I have received the Cadett's Lightning Shutter in good order, and find it an excellent piece of apparatus, combining all the requisites of an instantaneous and ordinary exposure—a great desideratum."

MARION & CO., 22 & 23 Soho Square, London, W.

PHOTOGRAPHIC MOUNTING ROLLER.

(BENNETT'S PATENT.)



This Roller will be found invaluable for Mounting Photographs, Prints, etc., as it leaves them perfectly flat and with a splendid surface, almost equal to burnishing.

By its use all danger of spoiling a print by using a dirty Roller is avoided, as the slightest trace of any foreign matter can be at once detected on the glass.

It is well made, strong, and durable, and forms a very handy adjunct to the mounting table.

PRICES. 3½ in., 2/6 6 in., 5/ 8 in., 7/6

THE "UNIVERSAL" LENS SHADE.

Every Photographer should have one of these simple—though necessary—little appliances.

Made of very thin light Metal in two sizes.

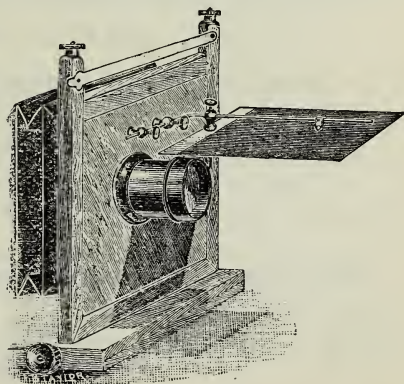
Inclusive of 2 small screws for screwing on front of any Camera,—the only fittings necessary.

No. 1, for Rectilinear or Single Lenses up to ½-plate size, size of shade 6½ × 4½ in.

2/.

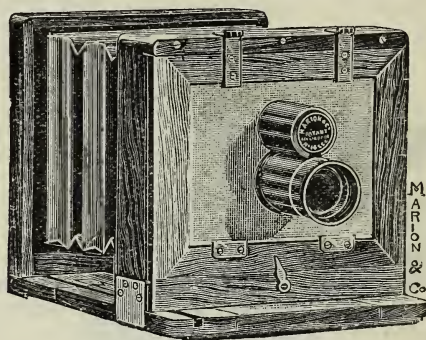
No. 2, for large Lenses, size of shade, 8½ × 6½ in.

3/.



MARION & CO., 22 & 23 Soho Square, London, W.

FOCUS MAGNIFIERS.



These are of the greatest possible convenience in getting perfectly sharp pictures; we recommend their constant use.

1s., 5s., and 10s. 6d. each.

WITH SELF-ATTACHMENT (as Illustration).

3s. 6d., 8s., and 12s. 6d. each.

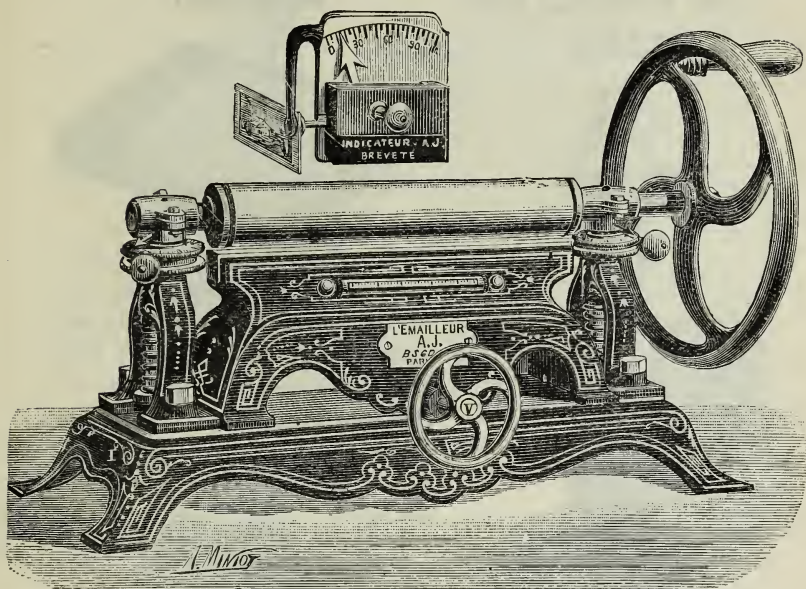
(PATENT, No. 14220.)

The Attachment can be fitted to Customers' own Magnifiers.

3s. each.

MARION & CO., 22 & 23 Soho Square, London, W.

THE A.J. BURNISHER.



FEATURES.

An Indicator for gauging thickness of mount, and corresponding graduated adjustments at each end of roller.

An Oscillating Roller with pressure derived from coiled springs.

The burnishing bar may be racked away from the roller by means of the wheel in front.

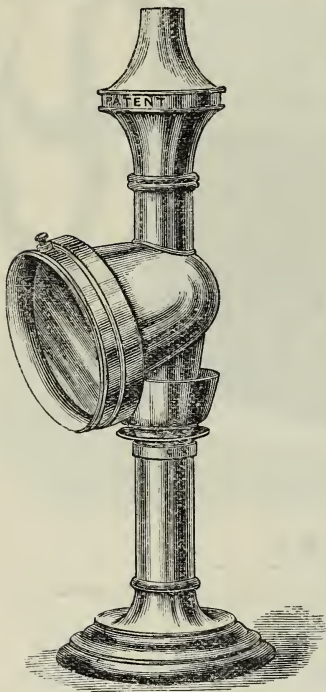
It is fitted with a Thermometer, so that the heat may be regulated to a nicety.

PRICES.

6 inch . . .	£4 9 0	16 inch . . .	£11 10 0
8 „ . . .	5 12 0	20 „ . . .	13 7 0
10 „ . . .	7 8 6	24 „ . . .	15 0 0
12 „ . . .	8 12 6		

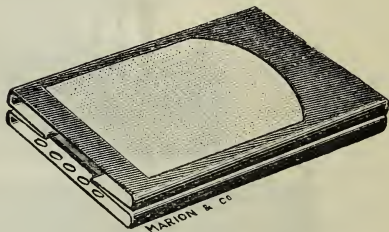
MARION & CO., 22 & 23 Soho Square, London, W.

THE PERFECTION LAMP.



Gives splendid safe light
from special Candles. Para-
bolic Reflector. Price 21s.
Candles 1s. 6d. lb. box.

FLAT TRAVELLING DARK ROOM LAMP.



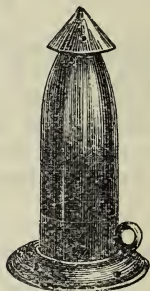
Folds quite flat, nothing breakable,
opened out easily and perfectly safe.
Burns a night-light. Price 5s. each.

THE REFLECTOR DARK ROOM LAMP.

So called because the light is re-
flected on to the plate and shades
the eyes.

Large size, with Paraffin Lamp, 23/9
Small size, with Colza Lamp, 9/

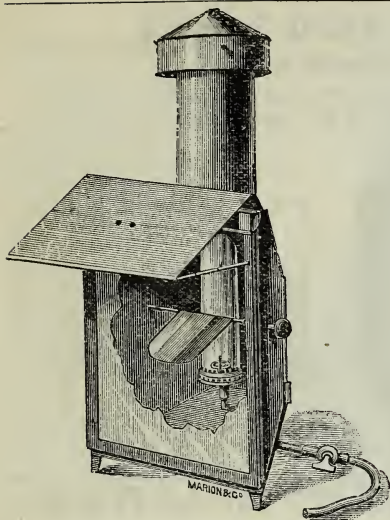
THE CANDLE LAMP.



The cheapest and most effective Ruby
Lamp in the market.

Price 1s. each.

MARION & CO., 22 & 23 Soho Square, London, W.

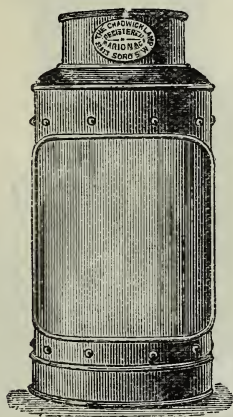


"PERFECT" DARK ROOM GAS LAMP.

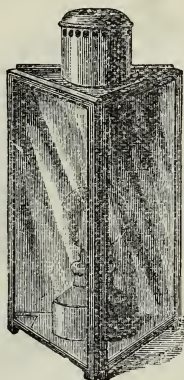
This Lamp is made of Copper, therefore gives off no bad smell. It is constructed to burn gas only—this can be easily connected by means of a piece of rubber tubing from any source of supply; there is also a small by-pass, to admit of the light being turned down to a very fine point, when not in use. As will be seen from the woodcut, the lamp has a circular burner, and in front of the burner a shade, which, when turned down, admits of no direct rays, but causes them to be reflected from the yellow sides and back of the lamp, thus giving an even light all over the surface of the glass. There are two grooves in the front, into which are slid a piece of orange-ruby glass, size 14×10 , and a sheet of yellow glass, allowing either or both to be used at pleasure. The reflector in front of the lamp shades the eyes from the injurious effect of the red light.

The most complete Dark Room Lamp made. Price 40s.

THE CHADWICK LAMP.



Gives a strong yet safe light from a Paraffin Lamp, through Ruby or Canary Fabric. Price 6s. A small ditto for night-light, 1s. each.



- No. 4. For colza oil, triangular, very compact, and gives a good light from both sides 10s.
 No. 4A. Do. Same as above but of larger size . . . 15s.

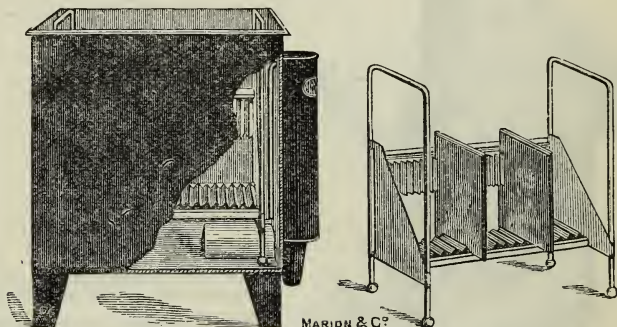
MARION & CO., 22 & 23 Soho Square, London, W'.

MARION'S PLATE WASHER & DRAINER.

Best Quality Material & Make.

To hold Twenty-four Plates with Syphon.

$4\frac{1}{2} \times 3\frac{1}{2}$ 9/9 ; $6\frac{1}{2} \times 4\frac{3}{4}$ 10/6 ; $8\frac{1}{2} \times 6\frac{1}{2}$ 12/ ; 10×8 13/6 ; 12×10 15/.



MARION'S PRINT WASHER.

Cheap and Effective.



No. 1—14 in. diameter	.	.	7/6 each.
„ 2—16 in. „	.	.	10/6 „
„ 3—18 in. „	.	.	12/ „
„ 4—23 in. „	.	.	20/ „

MARION & CO., 22 & 23 Soho Square, London, W.

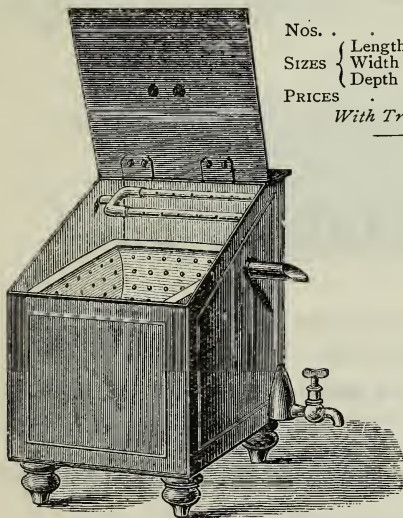
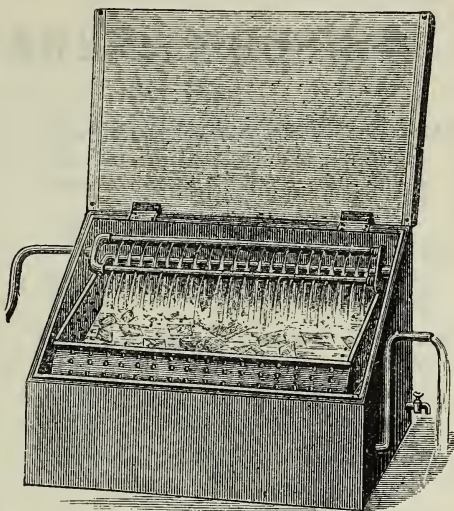
Marion's Registered Washing Apparatus.

THE great feature of this Apparatus consists in the rotary movement of the prints, caused by the system of inflow and outflow of the water.

The prints are in constant motion with the water; they circulate continuously in the trough from top to bottom, and never curl together. An hour and a half is sufficient to thoroughly wash them. This has been certified to by the public analyst of Brighton, who tested a batch of prints washed in this time, and found not the slightest trace of Hypo.

We have great confidence in recommending this Apparatus.

Very little water is required after the tank is once filled, and it need only be run off for the purpose of cleaning, about once every ten days.



Nos.		1.	2.	3.
SIZES	Length.	15 in.	21 in.	30 in.
	Width.	18 "	18 "	19½ "
	Depth.	19½ "	19½ "	20½ "
PRICES		40s.	50s.	60s.

With Trough enamelled, extra, 2/3, 3/1, 3/6.

This tank is specially made to meet the wants of Amateurs. It is exactly the same as the other, but the trough is porcelain, and can always be kept perfectly clean and fresh. The outside case is neatly japanned zinc, and has a good appearance. Made in one size only, 19 in. high, 13 in. wide, 14 in. long.

Price 50s.

From Dr. ALABONE, Lynton House, Highbury Quadrant, N.—“I have much pleasure in stating that, for the last eight months, I have been using your Washing Machine for Prints with *perfect success*. It is a most valuable adjunct. After remaining in the Washer from one and a half to two hours, the *very last* trace of Hypo is removed from the prints, thus saving an immense amount of time, and ensuring permanency of prints.”—October 24, 1885.

MARION & CO., 22 & 23 Soho Square, London, W.

TRIPOD CAMERA STANDS.

Marion's 4-fold Stand, packs easily in Portmanteau or Bag. Rigid. For $\frac{1}{4}$ -plate, 5×4 , and $\frac{1}{2}$ -plate Cameras, 7/ each.

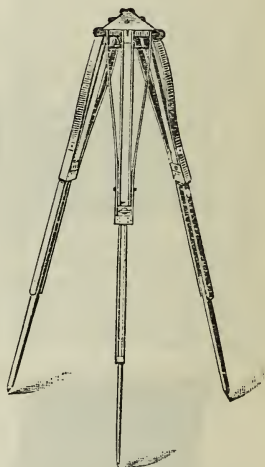
Marion's Cheap Pine Sliding Stand, very light and rigid. For Cameras up to $\frac{1}{2}$ -plate, 6/ each.

Ashford's Patent Stand, the most rigid and secure stand in the market, very light and strong. See woodcut. Made in 2-fold and 3-fold.

2-fold for $\frac{1}{2}$ and $\frac{1}{4}$ -plates, 18/6 ;
10 $\times$ 8, 21/ ; 12 $\times$ 10, 25/.

3-fold for Cameras up to $\frac{1}{4}$ -plate, 25/ ;
up to 12 $\times$ 10, 30/.

The Rigid Tripod, not folding, with leather covered brass triangle. 6 in. top, 20/ ; 8 in. top, 23/ ; 10 in. top, 28/.



ASHFORD'S STAND.

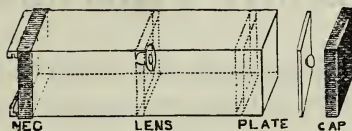
FOLDING CHANGING BAGS.

Triangle Changing Bag, can be fitted under any Tripod Stand for changing plates up to $8\frac{1}{2} \times 6\frac{1}{2}$. Very compact. 12/ each.

Claringbull's Developing & Changing Bag, or Tent, folds up to $27 \times 21 \times 3$, and yet allows of plates up to 12×10 being changed and developed with ease and comfort. Can be hung to a tree, a wall, or post, or used in any room. Well ventilated. Price 80/ each.

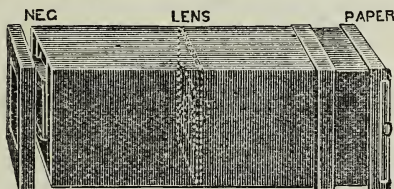
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GRIFFITHS' LANTERN SLIDE-MAKING CAMERA.



LANTERN Slides are made with this instrument at a moment's notice. You put the Negative in the groove at one end and a Cowan's Chloro-Bromide Plate at the other, and expose to daylight or artificial light, and then develop. Price complete, with good Lens— $\frac{1}{2}$ -plate, 12/6 ; $\frac{1}{4}$ -plate, 15/ ; 12×10 , 25/.

GRIFFITHS' ECONOMICAL ENLARGING CAMERA.



THIS instrument makes the production of Enlargements as easy and pleasant as the Lantern Slide Camera has made Slide making. Makes Enlargements up to 12×10 on Bromide Paper. Price, complete with Lens, 30/.

Best make Enlarging apparatus, with $8\frac{1}{4}$ in. Condensers & Triple Lamp, £8.

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FLASH-LIGHT PHOTOGRAPHY.

AMATEUR Photographers will readily recognise what an advantage Flash-Light Photography has put in their hands for "At Home" Portraiture, and Family Groups in the midst of their own surroundings, etc. Mr. Slingsby has brought this branch to a very high degree of perfection, his "Drawing-room" Set of Apparatus giving excellent results in Portraits or Groups.

The Drawing-room Set, complete with Stand, which can be set up and taken down readily in a few minutes, 4 lamps 4-way distributor, rubber tubing, and pneumatic blower which fires the four lamps simultaneously, packed in hinged-lid box, quite portable, £4.

Marion's Instantaneous Plates give the best results in Flash-Light Photography.

Voigtländer's Rapid Wide Angle Euryscope is the Lens we recommend for use with the Flash-light, particularly in confined spaces such as rooms, etc., — for plates, $6\frac{1}{2} \times 4\frac{3}{4}$, £4 : 13s. ; $8\frac{1}{2} \times 6\frac{1}{2}$, £6 : 2s. ; 12×10 , £10 ; 15×12 , £12 : 15s. These Lenses are all fitted with Iris Diaphragms.

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Their "Practical Guide to Photography," 15th thousand, 2/6.

Postage 3d. extra.

Robt. Johnson's
"THE ART OF RETOUCHING," 2/-

Postage 3d. extra.

W. K. Burton's
"Practical Guide to Photographic and
Photo-Mechanical Printing
Processes," 4/-

Postage 5d. extra.

Robert Slingsby on
"Flash-Light Photography," 4/-

Postage 5d. extra.

Marion & Co.'s
Catalogue of Photographic Apparatus
and Material, supplied gratis.

Purchasers of "Marion's" Plates will please note that their name is the first word on the label, and that none are genuine unless so labelled. It also denotes that the plates are our NEW make.

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MARION & CO.'S
MOUNTING SOLUTION
FOR
PHOTOGRAPHS



This Solution has been in use during the last twenty-five years in a large Photographic Establishment, and will be found to possess the following qualities :—

It has no disagreeable smell ;
It does not cockle the thinnest Mounts ;
It does not discolour the Photograph ;
It does not perish ;
And it is easily used.

DIRECTIONS FOR USE.—Place the Bottle in warm water, or on a stove, till the Solution is melted. Apply it with a stiff brush (which must be perfectly dry) to the back of the Photograph. Let the Photograph thus coated remain for a few seconds, and then place it on the Mount and press it well down.

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GLENFIELD PHOTOGRAPHIC STARCH.

The Manufacturer of the well-known "Glenfield" Starch has just introduced a new preparation made specially for mounting Photographs.

The merits of this new Starch consist in its superior adhesiveness, smoothness in working, and freedom from any chemical re-action or the influence of damp.

Testimonials have been received from some of the largest Photographers attesting to its superiority.

Mr. A. McNAB, Photographic Artist, Glasgow, writes—"It is very suitable for the purpose you make it."

Mr. JOHN FERGUS, Largs, writes—"That he finds it very smooth and considers it the best he has ever used for Mounting."

Messrs. H. & R. STILES, Kensington, write—"We are delighted in saying that the Glenfield Starch supplied by you has far exceeded anything we have yet used. The adhesive properties of this starch are excellent."

Price 8d. per lb. in Bags of 7, 14, 28, and 56 lb. each.

Sole Agents—MARION & CO.

DISCOUNT TO THE TRADE.

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WHYTE'S REGISTERED VIGNETTING FRAMES.

A simple arrangement for holding the Negative and Vignette Glass, specially adapted for use with Whyte's New Vignette Glasses.

The Vignetting Frame is made to fit into an ordinary printing frame the next size larger than the negative for which it is made ; thus a Vignetting Frame for a *half-plate* Negative requires to be fitted to a *whole-plate* printing frame.

Price of Half-plate Vignetting Frames 3/6 each.
Other sizes will be made and prices announced.

Sole Agents—MARION & CO.

WHYTE'S NEW VIGNETTE GLASSES.

These Vignette Glasses prepared in a new way are superior to anything yet introduced. They are beautifully soft, can be printed in sun or shade and require no special attention.

Price per dozen—C.D.V. 15/. Cabinet 22/. 1/1 30/.

MARION & CO., 22 & 23 Soho Square, London, W.

KITTO'S PATENT LEATHER FRAMES,

FOR PRODUCING
FRAMED OPALINES.

THESE Frames make quite a novelty in OPALINES, and also enable Photographers to use up their waste plates, of which there is generally an accumulation.

The method of Mounting the Photographs in optical contact with the glass is as follows :—

“Soak about one ounce of Gelatine in a pint of cold water, then gently warm in a water bath and strain it. Immerse both print and glass in this warm solution, placing them in contact under the surface of the liquid ; draw out the two together and rub down with a squeegee to get rid of all air bubbles.” The Opaline is then ready to be bound in the Kitto Frame, and the stout back glued on, making a very attractive Framed Opaline.

Prices of the Frames and Backs.

$4\frac{1}{4} \times 3\frac{1}{4}$ 3/ per doz.	$6\frac{1}{2} \times 4\frac{3}{4}$ 4/8 per doz.	
$8\frac{1}{2} \times 6\frac{1}{2}$ 7/8 per doz.	10×8 8/4 per doz.	12×10 10/ per doz.

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A LIST OF ALL HAND CAMERAS MADE OR SOLD BY MARION & CO.

	£	s.	d.
The Puck Camera and Lens, with 1 plate ready for exposure		1	8
The Puck Developing Set, Printing Set, and Camera and Lens, all complete with Instructions		7	4
The Miniature Landscape Camera, in polished mahogany, leather bellows, and Lens	1	1	0
The Book Camera, Dr. Krugener's, with 24 sheaths, for plates 1½ in. square, with a book of Instructions	2	5	0
The Book Camera, Dr. Krugener's, with 30 sheaths, for plates 3¼ in. square	7	10	0
Marion's Metal Miniature Hand Camera, with Lens and one Back, for plates 1¼ in. square	1	5	0
Marion's Metal Miniature Hand Camera, with Lens and one Back, for plates 2 in. square	2	5	0
Marion's Metal Miniature Hand Camera, with Lens and one Back, for plates 3¼ in. square	4	4	0
Marion's Metal Miniature Hand Camera, with Lens and one Back, for plates 4¼ × 3¼ in. square	5	5	0
Marion's Metal Miniature Hand Camera, with Lens and one Back, for plates 6½ × 4½ in. square	6	6	0
Marion's Parcel Camera, new make, with India-rubber bag Plate-holder, ¼-plate	4	0	0
Marion's Parcel Camera, new make, with India-rubber bag Plate-holder, ¼-plate, if covered in Leather	4	14	0
The Delta, for plates 3½ × 4¾ (9 c. × 12 c.) for 12 plates, with good Lens	3	3	0
The Delta, for plates 5½ × 7⅞ (13 c. × 18 c.) for 12 plates, with good Lens	5	5	0
The Delta, for plates, Stereoscopic, 3½ × 7 (9 c. × 18 c.) for 12 plates, with good Lens	5	5	0
The Normal Simplex, for plates 3½ × 4¾ (9 c. × 12 c.) for 12 plates ,, ,, ,, 5½ × 7⅞ (13 c. × 18 c.) ,,	8	8	0
,, ,, ,, Stereoscopic, 3½ × 7⅞ (9 c. × 18 c.) for 12 plates	14	3	0
,, ,, ,, Stereoscopic, 3½ × 7⅞ (9 c. × 18 c.) for 12 plates	14	14	0
The Radial, for 12 plates, 3¼ square	5	15	0
,, ,, 4¼ × 3¼	7	0	0
,, ,, 6½ × 4¾	12	0	0
The Beaumont, for 12 plates, 3¼ × 3¼ in preparation.			
,, ,, 4¼ × 3¼ ,,			

For full details of all the above refer to body of Catalogue.

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